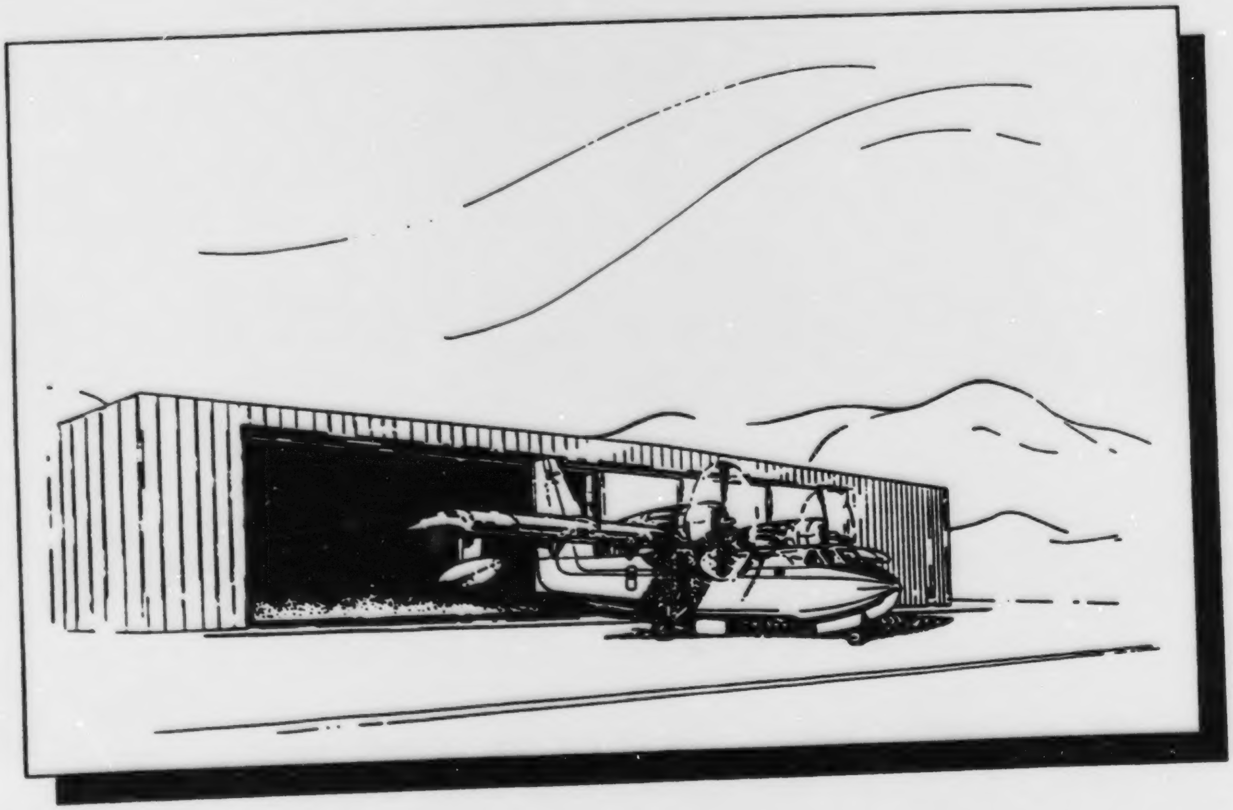
Feasibility and Socio-economic Study for the G.N.W.T. Aircraft Maintenance Facility

CONFIDENTIAL

FINAL REPORT



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REINDERS

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Executive Summary

1.0 EXECUTIVE SUMMARY

The Government of the Northwest Territories (GNWT), Department of Renewable Resources, contracts for the operation of a fleet of seven aircraft from six air tanker bases across the Fort Smith, Yellowknife and Inuvik regions. Over the past five years, changes in the airfleet composition have dictated a more intensive maintenance program and the updating and rationalizing of service facilities. The feasibility of relocating the current heavy maintenance program, now contracted in Edmonton, Alberta to the N.W.T., is an important consideration.

The GNWT has retained the Consulting firm of Reinders Northern Limited to determine the feasibility of developing an aircraft maintenance program based in the N.W.T. The study objective is to identify and recommend the most appropriate site and facility that would provide socio-economic benefits and meet operational and maintenance requirements. The following N.W.T. sites were considered:

- Fort Smith
- Fort Simpson
- Hay River
- Yellowknife
- Norman Wells
- Inuvik

A detailed technical and socio-economic evaluation of the above sites reveals that **Fort Smith is the favoured location in the NWT.** It is recommended that a new hangar complex be constructed at Fort Smith for an estimated cost of **$7.30 million** (1990 **$'s**). The Fort Smith site was chosen for the following reasons:

1. The Fire Operations Program Division administration centre is currently located in Fort Smith. The centralizing of maintenance and administrative functions would provide significant economies of scale and enhanced control of the maintenance operations.

2. Next to Yellowknife, Fort Smith is best positioned to take advantage of the significant social and economic benefits derived from this project due to the sophistication of its local economy. These benefits include the impact of almost $10 million (assuming 65% retention in the NWT and 2.0 multiplier) construction dollars in the first year and the infusion of over $1.5 million per year (assuming a 2.0 multiplier) of operating and maintenance expenditures. Yellowknife has not been selected as the prime site due to the prohibitively high site development costs that would be incurred at this location.

3. The Fort Smith site offers the least technical complexity affecting design and construction. These factors include good geotechnical conditions, adequate infrastructure, clear transitional and electronic zoning and room for future expansion.

4. Arctic College, Thebacha Campus is located in Fort Smith. The heavy maintenance operation will require a pool of trained Aircraft Maintenance Engineers in the future. Conceivably, the college could participate in the delivery of the A.M.E. curriculum under the NWT Apprenticeship Program should demand warrant.

Should the Facility be in the North?

A fundamental question is whether to locate the facility in the north or the south. An analysis of the existing contract maintenance operation in Edmonton (Municipal) reveals that the existing hangar is undersized, below standard and unable to accommodate aircraft larger than a DC-6. The overall facility will not be adequate to meet the long term heavy maintenance needs of the GNWT contract airfleet, and the maintenance contractor will have to consider operations at another location.

If an Edmonton location (at say Edmonton International) were added to the site selection matrix presented in Figure 7.1 of the report, it would score approximately 400, ranking it in middle of the scores for the other NWT communities. Fort Smith, Yellowknife and Hay River still score higher when the key factors of cost, socio-economic benefit and strategic location are taken into account.

It can be concluded therefore, that it is feasible to move the contract maintenance operation to the north. It can be expected however, that in doing so a cost premium will be incurred in both construction and operation of the facility.

The premium paid for construction in Fort Smith over an Edmonton location is about 25% or $1.80 million. This premium is off-set by the economic impact of a $10 million infusion into the economy in the first year.

A premium will also be paid in operating costs. Assuming a 20% difference in operating costs (utilities, leases and insurance), an annual premium of about $50,000 per year will be paid for operating in the north. Again, this premium is more than off-set by the infusion of over $1.50 million in operating and maintenance expenditures per year. This operating phase has the greatest impact because of the long term effect - essential for the development of a stable economy.

In summary, it is recommended that the GNWT contract airfleet maintenance operations be re-located to the NWT and that a new facility be built in Fort Smith where the maximum benefits of the project will be realized.

The new construction can be implemented with minimal impact to the existing airport operations. The project can be developed within the context of the Airport Master Plan for Fort Smith and is compatible with future development for the local community.

2.0 INTRODUCTION

The Government of the Northwest Territories, Department of Renewable Resources' contract airfleet is managed by the Fire Operations Program Division in Fort Smith, under the jurisdiction of its Director. The Director is responsible for the development and delivery of the Fire Operations Program as it relates to the aircraft operations and maintenance requirements.

The existing contract airfleet consists of a variety of fixed wing aircraft. The aircraft log about 1,500 hours annually in support of suppressing forest fires in the NWT and other provinces in Canada.

Maintenance of operational aircraft is carried out both in the field and at a maintenance base in Edmonton under subcontract to Conair. The overall program administration is centred in Fort Smith. Routine summer maintenance and inspections are also executed at six air tanker bases throughout the region, these being Fort Smith, Fort Simpson, Hay River, Yellowknife, Norman Wells and Inuvik. Each of the bases has been identified as a possible site for a permanent maintenance operation.

Over the past five years, the airfleet composition has changed significantly with the introduction of Canadair CL-215's. These new aircraft have dictated a more intensive maintenance program and the need for a modern maintenance facility.

Reinders Northern has been retained by the Government to determine the feasibility of developing an aircraft maintenance program based in the N.W.T. and to identify and recommend the most appropriate site and facility taking into account socio-economic benefits and operational and maintenance requirements.

The study first evaluates the six potential NWT sites in terms of both socio-economic and technical considerations. Capital cost estimates are also presented by site.

Second, key site selection criteria are identified and given a weighting factor. Each location is then assigned a score and the results are presented in a matrix format. The top ranking sites are identified. These scores are then compared to the "status quo" scenario where operations are contracted to an operator in Edmonton, Alberta.

Third, the space planning concepts are developed for the basic facility including hangar, support facilities and infrastructure. A description of the proposed building is also developed.

Finally, an implementation schedule for the facility is presented along with an outline of the consulting and construction services that will be required.

Introduction

Background

3.0 BACKGROUND

3.1 Existing Hangars

The Government of the Northwest Territories currently conducts its heavy maintenance and major inspections in Edmonton, Alberta under contract to a private operator.

With the deployment of CL-215 aircraft there is a need for more effective and rationalized operations. The Edmonton hangar is marginal at best, small in area and has limited potential to accommodate future growth. (See Section 8.0).

Several of the NWT's airports have greater potential to accommodate a modern heavy maintenance program better suited to the Government's needs for the following reasons:

- strategic location
- favourable socio-economic impacts
- good infrastructure
- centralized operations

3.2 Aircraft

With the recent introduction of CL-215 water bombers, the current operating fleet consists of the following aircraft:

Owned	Canadair CL-215	(2)
Leased	Douglas DC-6	(2)
	Piper Aerostar PA-600	(3)

There is a possibility that two additional CL-215's from the Yukon could be maintained in the new facility. In addition, a Hercules L-100-30 aircraft may be added to the fleet by the year 2000 as a replacement for the DC-6.

All of the aircraft operate in summer only. The maintenance season for these aircraft therefore, normally runs from September to April.

3.3 Personnel

Approximately 15 personnel could be employed at the new facility in both operations and administrative functions.

Site Evaluations - Socio-economic

4.0 SITE EVALUATIONS - SOCIO-ECONOMIC

In this chapter, we present an analysis of the socio-economic impacts in the six specified communities that will accrue from the construction and operation of an aircraft maintenance facility. First, we give consideration to the important question of whether the operation should be moved from Edmonton to the N.W.T.

4.1 Should the Facility be in the North?

A fundamental question is whether to locate the facility in the north or in the south. The distance to a southern location for modern aircraft is not significant. There are however, both technical and logistic reasons that make an Edmonton based operation unattractive in the longer term. These issues are discussed in Section 8.0 - Analysis of Contract Maintenance Operations in Edmonton. In this section, the critical socio-economic impacts of a northern based operation are explored.

Should a facility be constructed in one of the six communities, it can be expected that a premium will be paid for locating in the north. This premium will be realized in both construction costs and operating costs.

The premium paid for construction, assuming an average construction price of $7.30 million in the north over an Edmonton location is about 25% or $1.80 million. Assuming a 20% difference in operating costs, an annual premium of about $50,000 would be paid for operating in the north/per year. (See Section 6.0 - Cost Estimates, for the development of these costs).

Against these premiums, we weigh the socio-economic benefits of locating in the north. Under the construction phase, the premium of $1.80 million is offset by the economic impact of a $9.50 million ($7.30 million x 65% retention x NWT multiplier of 2) infusion into the economy.

Under the operating phase, the $50,000 per year premium is offset by the economic impact of a $1.50 million ($240,000 operating cost plus 530,000 wages x multiplier of 2) infusion into the economy. The operating phase has the greatest impact because of the long term effect, essential for the development of a stable economy.

These benefits will not be directly felt by the GNWT. There is not likely to be a noticeable reduction in recipients of social assistance, or financial savings in other areas of government. However, such an infusion into an economy will have numerous indirect benefits to the GNWT and NWT residents that would not occur if the facility is placed in a southern location such as Edmonton.

4.2 What are the Specific Socio-Economic Impacts?

The benefits that would result from the construction of the facility will be numerous. These benefits are both short-term and long-term in nature. The benefits that we have identified include:

- Local employment during construction.
- Local employment during operation.
- Hiring of local contractors and sub-trades.
- Acquisition of materials from local suppliers.
- Accommodation for work crews during the construction phases.
- Demand for housing by permanent staff.
- Reduction of dependency on financial assistance.

It should be noted that the NWT economy is relatively small. Few communities possess sufficient infrastructure to enable them to take full advantage of a major construction project. The economy of an entire region will likely feel the impact of this project.

The degree to which benefits will be dispersed to communities other than the selected community is dependent on several variable factors. A major factor is the quality and availability of a local labour force. This project provides much greater benefit to skilled tradespeople than it will to unskilled labourers, both in the construction and operation phases.

Another variable is the location of the successful building contractor and the sub-trades employed by that contractor. It is possible to locate a facility in one community and have the contractor and sub-contractors located in other communities, or possibly from outside the NWT. In such a case, the community would only obtain the benefit accruing to local labourers during the construction phase.

The multiplier effect on an injection to a local economy varies between communities. This is a direct result of the sophistication and extent of the infrastructure developed in the communities. For instance, in a well developed community economy, maximum benefit is obtained as proportionately more dollars are spent locally. In less well developed community economies, more dollars flow out of the community to other communities or, in some instances, out of the NWT. Therefore, the multipliers we use in this analysis reflect the degree of sophistication of each community's economy.

4.3 Benefits Will Accrue to Business

The total capital costs associated with the construction of the facility ranges from $7.00 million to $11.05 million. Annual operating costs are estimated to be approximately $210,000 (excluding lease costs).

We expect that contractors and suppliers of materials will receive an initial benefit equal to 65% of the construction costs. We anticipate 35% of the cost will be incurred outside the NWT. A major component of the costs going outside of the NWT will be for the supply of the steel building structure. This cost alone is approximately 25% of the total costs.

A review of NWT businesses indicates that there are suppliers of goods and services for all other aspects of the construction project. Figure 4.1 indicates the type and location of suppliers presently in the NWT in the affected communities. The Yellowknife business community is better positioned to take advantage of this project. Fort Smith and Inuvik are also well positioned. There are several suppliers in almost all the categories identified. This is certainly not the case with the other communities.

Norman Wells is in the poorest position to take advantage of the project and is closely followed by Hay River and Fort Simpson. In the event that the project is implemented in one of the lesser prepared communities, fewer of the benefits will be received in that community, as opposed to a community that is well positioned for the project. The benefits will be dispersed to communities with suppliers and contractors that are absent in the selected community.

This situation has a significant effect on the magnitude of any economic stimulus provided to the selected community. In this regard, Yellowknife has the highest potential to retain maximum benefits, with Fort Smith and Inuvik coming in close second.

FIGURE 4.1

Potential Suppliers of Goods & Services

	Ft. Simp.	Ft. Sm.	H.R.	Inu.	N.W.	YK
Building Contractors	3	4	2	5	1	12
Electrical Contractors	1	3	4	4	3	6
Plumbing Contractors	1	4	3	2	1	8
Carpenters	1	3	3	2	0	6
Excavation Contractors	0	3	3	0	1	8
Paving Contractors	0	0	0	0	0	3
Concrete Suppliers	1	1	3	0	0	1
Electrical Suppliers	0	0	2	0	0	3
Steel Building Suppliers	0	0	2	0	0	0
Building Supplies	1	1	2	1	0	2
Foundation Constructors	0	0	0	1	0	3

In the short term it can be expected that accommodation for tradespeople and labourers would need to be provided where these individuals come in from outside locations. The relative magnitude of this benefit between communities is related to the preparedness of the communities to undertake the project. For instance, in Yellowknife, where building contractors and suppliers already exist in all categories, this benefit would be minimal. Conversely, in Norman Wells, where many of the contractors would have to come in from outside communities, this benefit would be maximized.

In the long term, the creation of 10 to 15 permanent positions would create additional demand for housing. It would be expected that the economic impact of that demand would be greater in communities where there is no existing housing market. This demand would stimulate the construction of new housing with related spin-off benefits. In communities with a developed housing market and surplus housing, the effect of this benefit would be reduced. From an operational standpoint, the scarcity of suitable housing will create short term problems accommodating permanent staff. In areas with limited housing markets, prospective employees would be less inclined to invest in their own housing as opposed to renting accommodation.

During the construction phase, it is expected that 44 tradespeople and 32 labourers will be employed over the 50 week construction period. The majority of the work will be performed by skilled tradespeople as opposed to unskilled labourers. Over 60% of the unskilled labour will be required during the first 10 weeks of construction; the remainder would be required over the remaining 40 weeks of the project.

Figure 4.2

Use of Labour Force

	Tradespeople	Labourers
Phase I - 10 Weeks	3	3
Site Preparation	2	6
Concrete Forming	2	6
Foundations	3	5
Concrete Floors	10	20
Phase II - 20 Weeks	12	3
Steel Structure	3	1
Windows/Doors	2	2
Carpeting	17	16

Phase III - 20 Weeks	4	1
Plumbing	4	1
Electrical	4	1
HVAC	5	3
Paving	17	6
	44	32

The total economic impact in the form of wages, including benefits, in the Northwest Territories would be in excess of $1 million. The indirect spending created when employees of the project spend money on supplies and services from other companies and induced spending when employees of the supplies and services company, in turn, spend their income, should also be considered when establishing the economic impact of this project. In estimating the multiplier effect of employment on the NWT, a multiplier of 2.0 is often used. In the Canadian Department of Regional Economic Expansion's Report, "Employment and Occupational Impacts" ratios range from 1.93 for Manitoba to 3.35 for Newfoundland.

We have made some assumptions to modify this multiplier for the various communities being evaluated (see Figure 4.3). This modification is necessary as the degree of sophistication of a local economy will influence the extent to which economic benefits will be retained within the community. In less developed communities, one would expect to find consumer spending being directed outside the boundaries of the community and, in some cases, given proximity to southern jurisdictions, these benefits flow out of the NWT with no multiplier effect.

FIGURE 4.3

Community Multipliers

Fort Simpson	1.6
Fort Smith	1.8
Hay River	2.2
Inuvik	2.0
Norman Wells	1.6
Yellowknife	2.5

In evaluating the multipliers for the selected communities, we have referred to the Department of Economic Development & Tourism's economic development strategy, "Building on Strengths: A Community Based Approach". The report identifies three groups of communities; developed market communities, emerging market communities, and resource communities. The first grouping are communities with the greatest potential for displacing major southern supply centres. Communities so identified are Yellowknife, Fort Smith, Hay River and Inuvik. Emerging market communities are those with significant potential to expand their role as regional supply centres and to expand their local range of goods and services. Fort Simpson and Norman Wells have been placed in this group. With that in mind, we have established multipliers for the individual communities.

Another benefit to business will be the training provided during the construction phase and during operations. During construction, unskilled labourers will gain experience in the construction industry. Skills learned here can be easily transported to other construction projects that may occur in the region. This also gives the individuals more opportunity to work in other locations of the NWT. It is recognized that migration of labourers in the NWT has been limited.

During operations, it is anticipated that apprenticeship programs sponsored by the GNWT will be accessed by NWT residents. The training they receive under this program will give them the opportunity to seek employment in the private sector. A large number of the air carriers in the NWT presently conduct maintenance in-house.

The GNWT Apprenticeship Program is administered by the Advanced Education Division of the GNWT, Department of Education. The program is jointly funded by the Federal and Territorial governments.

The Aircraft Maintenance Engineer (A.M.E.) Program prepares apprentices to inspect and maintain a variety of aircraft types that are currently operated in the North. Training for the program is carried out at education facilities located in Winnipeg, Manitoba.

Should a new facility be built in the North, a pool of trained A.M.E.'s will be required. Depending on the contractor involved, a number of these may relocate to the NWT. Additional and future A.M.E.'s will need to be sourced in the NWT. The apprenticeship program could provide funding for these trainees.

There is a possibility that Arctic College in Fort Smith could become involved with the A.M.E. program should demand warrant.

There is also the possibility that the facility will be made available to third party private sector carriers who presently have aircraft maintenance performed outside of the NWT. A review of present air carriers indicates that revenue from third parties could be generated, primarily from general aviation operators.

Due to the itinerant nature of these third party operations, it is difficult to quantify the direct financial benefit over the long term. As a result, the impact from third party maintenance has been evaluated qualitatively and included in the socio-economic evaluation matrix (Figure 4.6).

4.4 The Social Benefits

This project carries with it a certain level of social benefit. The relatively short term nature and size of the project reduces the magnitude of benefits. In Figure 4.4, we present population, potential labour force and unemployment rates in the six specified communities. In general, the smaller communities suffer the highest rates of unemployment although not necessarily the greatest absolute number of unemployed.

FIGURE 4.4

Labour Force and Unemployment Rates*

	Population	Labour Force	Unemployment Rate
Fort Simpson	1000	543	25 %
Fort Smith	2512	1257	15 %
Hay River**	3066	1891	16 %
Inuvik	2773	1732	6 %
Norman Wells	502	326	22 %
Yellowknife	13,511	8,008	4 %

* ce: 1989 NWT Labour Force Survey, June 1989

** includes Hay River Reserve and Hay River Corridor

The recruitment of unskilled labourers from the unemployed in each community is not expected to be great. Figure 4.2 sets out the use of labour force during each work phase and the duration of those phases. The use of casual labourers is heavily weighted to Phase One of the project, which is only of a 10 week duration. That, combined with the fact that the work tasks within that phase do not run concurrently, indicates that there will only be a moderate impact on the unemployed for a specific community. We have assumed that tradespeople are not presently unemployed or, if so, the numbers are not significant.

In the longer term, the more important measure of the impact of the project is the level of skill transfer that will take place. As mentioned previously, this is expected during both the construction phase and, to a greater extent, during the operating phase. The apprenticeship program will increase the employability of individuals.

There will be a reduction in the level of dependency on financial assistance provided by the Department of Social Services during the construction phase. Assuming 40% of the unskilled labourers hired are presently receiving financial assistance, and 25% of those are single with the remaining 15% receiving support for a family of three, savings to the GNWT could be expected to be:

- four recipients X $177/month = $700/month or $3500 over the life of the project
- eight recipients x $428/month - $3024/month or $15,120 over the project
- Total = $18,620.

4.5 The Long Term Benefits

This project is expected to have some longer term benefits based upon the operations of the facility. These have been discussed in the context of business benefits and social benefits.

Our estimate of operating benefits indicates that $750,000 per year would be injected to the local economy by this facility, $540,000 will come from wages and benefits paid to permanent employees and the administrative staff. Another $210,000 (excluding lease payments) will be required to operate and maintain the facility. It should be noted that not all facility operating costs will necessary flow into the local community. For instance, payments to NWTPC do not directly flow into the local economy although there is an impact of such expenditures.

FIGURE 4.5

Estimate of Operating Benefits/per Year

Permanent employees, 10 x 45,000	$450,000
Administrative, 3 x 30,000	90,000
	540,000
Facility operating and maintenance costs (average)	210,000
	$750,000

The facility will also generate an increased demand for housing. The permanent positions presently being considered do not necessarily reside in those communities. The creation of these positions increase the demand for housing. This demand may manifest itself in a number of ways. It may generate the construction of new housing, either by the employees or by business entrepreneurs to provide rental facilities. It may also manifest itself in the rental of existing facilities or the purchase of existing facilities.

Another long term benefit are those occurring from the apprenticeship program. With a major employer of aircraft maintenance personnel, it is likely that higher enrolment in the apprenticeship program will be experienced. Presently, there are seven individuals in the program.

4.6 Where Will the Greatest Socio-Economic Impact be Felt?

In evaluating the impact this project will have on the six specified communities, we have developed an evaluation matrix to assist in arriving at a relative ranking of each of the communities. The criteria we have developed are as follows:

- Retention of economic benefits.
  - Construction
    - Use of local labour
    - Use of local suppliers
    - Combination of crews
  - Operation
    - Use of local labour
    - Use of local suppliers
    - Demand for new housing
- Multiplier Effect on Benefits
- Capacity to Participate
  - Construction
    - Available skilled labour force
    - Presence of local suppliers
    - Adequate accommodation
  - Operations
    - Skilled labour force
    - Adequate housing
    - Adequate schooling

- Impact Upon Employment
  - Construction
    - Potential mobilization of local labour
    - Reduced Dependency on Government Financial Assistance
  - Operations
    - Creation of New Jobs for Locals
  - Apprenticeship Program
    - Availability of local candidates
    - Alternative employment opportunities
- Third Party Aircraft Servicing

The weighting of the individual criteria is shown in Figure 4.6. Heavy emphasis has been placed on the economic benefits, the multiplier effect, and the capacity for a community to participate and therefore maximize the benefit. Less importance has been placed upon the impact on unemployment as an analysis of this project does not indicate significant reductions of unemployment in any of the communities. In evaluating the economic benefits, we have examined the use of local labour, suppliers and accommodation during the construction and operating phases. This gives us some measure of the total economic benefit that is expected to flow to a community.

The multiplier effect is an estimation of the impact a shock to the local economy will have. In larger, more developed community economies, the impact can be expected to be greater as more local purchasing will occur. In less developed community economies, proportionately fewer dollars are spent locally with the remainder being spent outside the community or the territories.

A third major criterion, the capacity to participate, is a measure of the community's ability to mobilize and take full advantage of the shock to the local economy. If skilled labour, suppliers, accommodation are not available during the construction phase, then the contractors must look elsewhere to bring these resources to the project. During operations, there must be skilled labour, adequate housing and other amenities to attract long term staff to operate the facility.

The impact on unemployment is the degree to which the project is able to both reduce unemployment rates and dependency on government financial assistance, in the short term and long term.

Figure 4.6

Socio-economic Evaluation/Matrix

Criteria	% Weighting	F. Sim.	F. Sm.	H.R.	In.	N.W.	YK
Economic Benefits							
• Construction							
• use local labour	8	16	40	32	24	8	48
• use local suppliers	6	12	24	30	18	6	36
• crew accommodation	4	8	20	12	24	16	4
• Operation							
• use local labour	4	4	24	16	12	8	20
• use local suppliers	4	8	20	16	12	4	24
• demand/new housing	4	24	8	12	16	20	4
	30	72	136	118	106	62	136
Multiplier Effect on benefits	25	50	75	125	100	25	150
Capacity to Participate							
• Construction							
• skilled labour	4	8	20	12	16	4	24
• local suppliers	4	8	16	20	12	4	24
• accommodation	2	4	10	6	12	8	2
• Operations							
• skilled labour	4	4	20	12	16	8	24
• adequate housing	4	8	24	16	12	4	20
• adequate schooling	2	4	10	8	6	2	12
	20	36	100	74	74	30	106
Impact/Unemployment							
• Construction							
• potential mobilization local labour	5	30	20	15	10	25	5
• reduced dependency of other gov't funding	5	30	20	15	10	25	5
• Operation							
• new jobs/locals	5	30	15	20	10	25	5
	15	90	55	50	30	75	15
Apprenticeship Program							
• availability local candidates	3	10	25	20	15	5	30
• alternative employment opportunities	2	5	25	15	20	10	30
	5	15	50	35	35	15	60
Third Party Servicing	5	15	25	20	10	5	30
TOTAL	100	278	441	422	355	232	497
RANK		5	2	3	4	6	1

4.7 Conclusions

From our evaluation, Yellowknife receives the greatest socio-economic benefit if this project proceeds. This is primarily based upon the fact that the community has sufficient capacity to fully participate in the project. In addition, the local economy is sophisticated enough to retain and multiply maximum benefits from the project, both in the long term and short term period. The impact on unemployment in Yellowknife, however, is the poorest of all six. The absolute impact would be expected to be about the same, however, the overall impact to Yellowknife would be invisible.

Fort Smith and Hay River will receive similar socio-economic benefits. Fort Smith will feel a greater impact on unemployment and may have a slightly higher capacity to participate in this project. Fort Smith has advantages for the operating phase in terms of housing and schooling. Both communities will receive a significant impact if the project were to proceed.

As you move to the less sophisticated communities, the economic benefits decrease. It should be kept in mind, however, that the total benefit to the NWT remains almost constant regardless of the community selected. If there are not local suppliers available in the selected community, suppliers in other NWT communities will fill the void.

Site Evaluations - Technical

5.0 SITE EVALUATION - TECHNICAL

5.1 General

The technical feasibility of locating the aircraft maintenance facility was analyzed at six airports in the Northwest territories (See figure 5.1):

Yellowknife
Fort Smith
Hay River
Fort Simpson
Norman Wells
Inuvik

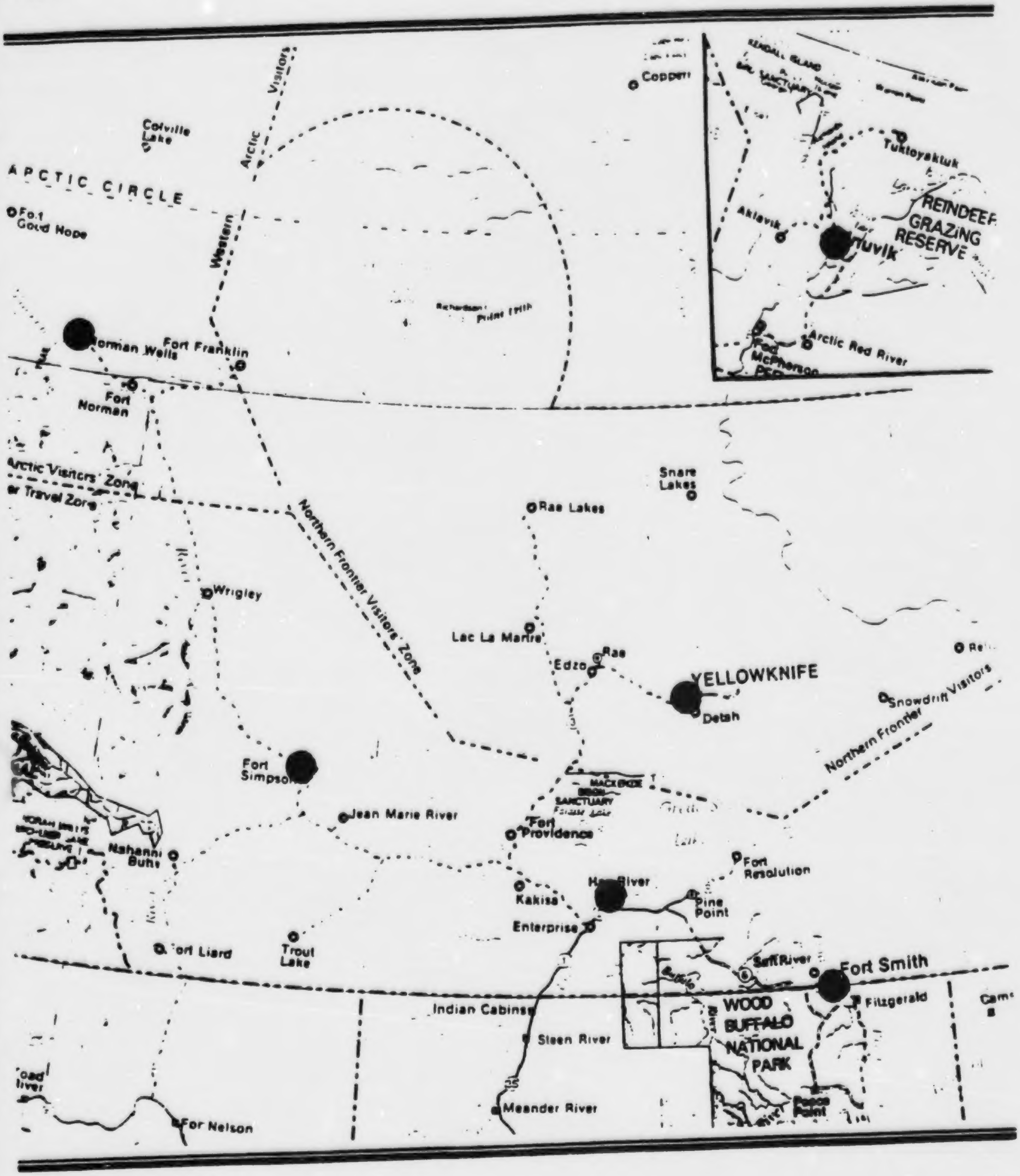
Existing GNWT tanker operations are currently deployed at each of these locations. Analysis indicates that a suitable aircraft maintenance facility can be located at any of the listed sites, although some have restrictions on building configuration, expansion potential and infrastructure compatibility.

The following discussion outlines these restrictions on a site by site basis. Detailed geotechnical evaluations for each site are presented in Appendix "B".

5.2 Airfield Considerations

With the exception of Yellowknife, whose main runway is 2280 m long, every site has a paved runway of at least 1829 m. This is sufficient for CL-215 and DC-6 operations requiring a minimum of 1680 m. and for L-100-30 operations which require some 1500 m. runway length, (i.e. assuming gross weight of 150,000 lbs, standard temperature, half flaps and no wind or runway slope).

Figure 5.1


Copperr
Colville Lake
ARCTIC CIRCLE
Western Arctic Visitors
Fort Good Hope
Richardson Point (Hth
Norman Wells
Fort Franklin
Fort Norman
Arctic Visitors' Zone
er Travel Zone
Northern Frontier Visitors' Zone
Snare Lakes
Rae Lakes
Wrigley
Lac La Martre
Edzo
Rae
YELLOWKNIFE
Detah
Snowdrift
Northern Frontier Visitors
Fort Simpson
Jean Marie River
MACKENZIE BISON SANCTUARY
Fort Providence
Nahanni Butte
Fort Resolution
Hay River
Kakisa
Pine Point
Enterprise
Fort Liard
Trout Lake
Salt River
Fort Smith
Indian Cabins
Steen River
Fitzgerald
WOOD BUFFALO NATIONAL PARK
Meander River
Peace Point
Fort Nelson
Tuktoyaktuk
REINDEER GRAZING RESERVE
Aklavik
Inuvik
Arctic Red River
Fort McPherson

The pavement loading rating for each site is as follows:

Site	PLR
Yellowknife	12
Hay River	9
Fort Smith	12
Fort Simpson	9
Norman Wells	9
Inuvik	11

These pavement loading ratings indicate that each airport can sustain operations for CL-215, DC-6, and L-100-30 aircraft.

5.3 Meterological Data

All sites are primarily served by a single runway with the exception of Yellowknife which has two runways and there is little evidence to indicate that meterological conditions hamper airport operations at any one site. Training air crew staff forms an important element in the program. The further south the location, the better the opportunity for training in the spring when waterways are ice clear. This factor favours Fort Smith as staging point for training CL-215 crews. Yellowknife, Fort Simpson and Hay River are next in rank order, followed by Norman Wells and Inuvik.

5.4 Airport Infrastructure

Each airport is equipped with varying airfield and navigational aids that can support development of a maintenance facility. Services (FSS, CFR) and fuelling are also provided in varying degrees at the sites and should not preclude any proposed development.

5.5 Noise

In spite of the close proximity of some of the communities in relation to their airports, (Norman Wells, Hay River...) there is little evidence that noise will be perceived as a problem. Heavy aircraft maintenance operations will not attract a high number of flights. Engine run up aprons can be located in areas to minimize noise impact. In many of the communities, the airport is the primary communication link and this in itself makes airport noise more acceptable to communities like Norman Wells than to residents of the larger southern communities.

5.6 Land Tenure

In each case, every airport site is owned and operated by Transport Canada. According to the land use plans of each airport, there is leasable land available at all sites to permit the location of an aircraft maintenance facility. The exception to this condition is Yellowknife where extensive airside development is required to gain access. No other technical impediments for the lease of lands are seen to exist.

5.7 Aircraft Apron and Vehicle Parking

The criteria to be used for parking has been established by GNWT. They are:

Apron Parking:	CL-215	(2)
	DC-6	(2)
Vehicle Parking:	20 Vehicles	

Due to the expected replacement of the DC-6 by the Hercules L-100-30, we consider that it would be prudent to allow provision for the Hercules at this time and therefore, an apron of approximately 8500 m² has been allowed for in the cost estimates.

Spatial separations for aircraft apron parking and circulation have been determined according to Transport Canada Manual TP-312E.

It is recommended that the circulation area of the apron be of flexible asphalt construction.

Due to the orientation of the hangar so that the hangar doors are wind swept, the aircraft engine performance run-up area must be aligned parallel with the hangar door and may be located either on the apron or occupy one of the parking positions.

Tie-down areas consisting of three anchors per group (two for wings and one for the tail) for the smaller aircraft are to be provided at 20 metre intervals along the apron area.

5.8 Yellowknife

a) Overview

The Yellowknife airport is located at 62° 28' N and 114° 26' W within the City boundary. The airport serves as the major point of domestic air carrier service for the MacKenzie Valley, and is the site of a military Forward Operating Location. From a strategic point of view, it is located in the capital city of the Northwest Territories, where there is significant government presence. CL-215 operations are based at Yellowknife in the summer months 40% of the time.

Yellowknife does not have a year round road access, as there are periods during freeze-up and break-up when it is not possible to cross the Mackenzie River.

b) Potential Site(s)

An area of land located some 1000 metres east of the air terminal building, and immediately adjacent to the existing GNWT air tanker base was until recently, the only site on the airport with suitable landside and airside access. There are no known height or line of site constraints at this location, the closest restriction being the VOR/DME location some 800 m. away. Unfortunately, this particular site was recently leased by Transport Canada to Stewart Holdings Ltd. and is therefore not available to the GNWT.

The only alternative location is the area of undeveloped land east of the existing GNWT base. This site is considered feasible but is characterized by prohibitively high site development costs. Required are substantial amounts of fill, the removal of an existing rock out-crop and construction of a 400 metre extension to Taxiway Bravo.

5.9 Fort Smith

a) Overview

The Fort Smith airport is located immediately west of the town of Fort Smith at 60° 01'N and 111° 58'W. The airport is classified as regional with the majority of aircraft being classified as itinerant general aviation. Fort Smith has year round road and highway access to Southern Canada and to other points in the Northwest Territories.

The Fort Smith location is important from a strategic standpoint as the Territorial Forest Fire Centre is based in this community. Fort Smith is also the home of Arctic College, Thebacha Campus, and a regional administration centre for Territorial Government. Well developed recreational facilities such as a golf club and a ski club are situated in Fort Smith.

Fort Smith acts as a secondary base for the CL-215 operations.

b) Potential Site(s)

The airport master plan identifies two areas that can be developed for a future aircraft maintenance facility:

1. An area designated as 'Fixed Wing G.A. Reserve' located northeast of the air terminal apron, and
2. An area designated as 'Helicopter G.A. Reserve' located east of Apron II, the area now used as the air tanker base, south of the main access road.

Recent discussions with government staff have indicated that either area could be used for the hangar project, and the 'Helicopter G.A. Reserve' has been favoured as the proposed site.

Governing restrictions over this site are height zoning from Runway 11-29 necessitating buildings to be set back 250 m from the runway centreline, and E.M.I. (Electro-Magnetic Interference) restrictions from the receiver located near the terminal building. It is not felt that these restrictions would impede the proposed hangar development.

c) Expansion

The favoured site for the Fort Smith airport affords much opportunity for expansion in the direction southwards toward Runway 11-29, and eastward along the access road toward the townsite.

d) Airside Infrastructure

The selection of development of lands southeast of the existing air tanker site offers the advantage that it would not require an immediate decision on the abandonment of Runway 2-20, which is a concern for the airport.

Implementation of this option would however, necessitate extending Taxiway Charlie some 150 metres eastward. Helicopter reserve areas would then likely be dedicated for the lands south of Runway 2-20.

e) Landside Infrastructure

Groundside access to the favoured site in Fort Smith is easily achieved off the main access road.

The town water system runs to within 80 m of the proposed site and could be utilized for the development.

The airport is presently drained by surface grading and a system of ditches. No problems are envisioned with the construction of this system for the proposed hangar development.

The airport had their sewage system modified in 1985 to be connected into the town's central system. The line passes some 300 m from the favoured site and would have to be evaluated to see if a connection is feasible and cost effective. Tanking the sewage waste should be considered as an alternative.

The airport has adequate capacity for electrical power and telecommunication lines.

5.10 Hay River

a) Overview

The Hay River airport is located at 60° 50' N and 115° 47' W approximately 4 km from the downtown core. The site is located on Vale Island at the mouth of the Hay River entering Great Slave Lake. The airport is classified as regional, with the majority of aircraft movements being itinerant commercial. There are at present no major aircraft maintenance hangars in Hay River.

The DC-6 operation is based in Hay River during the summer 40% of the time. The base does not support CL-215 operations due to the lack of suitable lakes for the proper utilization of the aircraft.

Hay River has road and rail connections, and is a terminus for barge transportation along the Mackenzie River system.

b) Potential Site(s)

The Hay River airport masterplan identifies "Area #3" as a possible site for the development of an aircraft maintenance facility. This area, located between the CNR branch/Hwy. 2, the apron, and runway 13-31, represents the best opportunity for development. Buildings must be set back some 250 m from the centreline of Runway 13-31 for height zoning, and the effects of the localizer for Runway 13 are not considered to affect development.

c) Expansion

The Hay River site is as yet undeveloped, but has more than adequate room to accommodate the base development as well as additional space for future expansion should the need arise.

d) Airside Infrastructure

The suggested site at Hay River has good primary runway access and strong orientation to the apron, air terminal and other support services. However, an extension to Taxiway Bravo, from the apron south would have to be provided for access.

e) Landside Infrastructure

The development of the Hay River site offers direct convenient groundside access from Highway 2, and would require the construction of an intersection to access the Hangar site. With respect to services, there do not appear to be problems with electrical and telecommunication links. Although the air terminal building is supplied with potable water via a 150 mm supply line from the town, a hangar facility at Hay River will probably rely on tanked storage or wells for water supply. The existing sewage system at the airport does not work properly and the need for tanked sewage storage is also a possibility until the town connects their system to the airport. Storm water drainage can be handled by overland ditch and drainage lines.

5.11 Fort Simpson

a) Overview

The airport at Fort Simpson is located at 61° 45' N and 121° 14' W, approximately 16 km southeast of the village of Fort Simpson town centre. Access to the airport is via Highway No. 1. The airport is classified as regional, providing local aviation needs and connections to Yellowknife.

Fort Simpson is an administrative centre for the Government of the Northwest Territories, with eight federal government departments and three crown corporations located in the village. The private sector in Fort Simpson is primarily based on tourism and natural resource development.

Fort Simpson does not have year round road access, as there are periods during freeze-up and break-up when it is not possible to cross the MacKenzie River. Access to the airport from the community is via gravel road.

b) Potential Site(s)

Lands immediately east of Taxiway Delta, extending to the airport boundary/access road, are available for hangar development. These areas are adjacent to the existing GNWT air tanker base.

The favoured areas for Fort Simpson are not restricted by airport height zoning and do not appear to be influenced by the airport radio receiver located near the terminal building.

c) Expansion

The favoured site at the Fort Simpson airport can accommodate the base hangar development. There is also ample space for any expansion that might be necessary in the future.

d) Airside Infrastructure

Taxiway Delta joins the proposed development area and provides access.

e) Landside Infrastructure

The site currently has groundside access via gravel roadways. Should the hangar development be located on the northern extremity of the developable area then allowances for the construction of landside roadways around the perimeter of the airside development would have to be constructed.

Discussions with government officials have indicated that there are electrical supply problems with this site. The extent of this deficiency needs closer evaluation should Fort Simpson be deemed as a favourable site location.

Municipal services are limited and it is suggested that water and sewage systems would need to be tanked facilities. Surface drainage via overland drainage systems are directed towards the Laird River and are not deemed to be a problem.

5.12 Inuvik

a) Overview

The Inuvik airport is located at 68° 21' N and 113° 43' W. It is situated some 5 km southeast of the main town site. The airport is classified as regional and serves as the air terminus for the transportation system from the south. Because of its location in the north, the Inuvik airport serves as a vital link in the transportation system. The town of Inuvik acts as the administrative centre for the Northwest Territorial Government's Inuvik region. Inuvik also serves as a Forward Operating Location for Canadian and U.S. military defence purposes.

The Inuvik airport acts as a secondary base for the CL-215 operations and the

Fire Operations Program currently shares space in the Environment Canada hangar and apron area.

b) Potential Sites

There is adequate land for the development of a hangar base at Inuvik airport. One of the most feasible is located immediately adjacent to the Environment Canada hangar off Taxiway Charlie, some 400 metres northeast of the firehall. There are no height or E.M.I. restrictions to limit hangar development in this area.

c) Expansion

The favoured site at the Inuvik airport has sufficient land area for the basic hangar requirement, and desired apron space. There is, however, little available land area for expansion due to existing tenants.

d) Airside Infrastructure

Airside access to the site is readily available via Taxiway Charlie. A portion of this taxiway, however, is gravel surfaced.

e) Landside Infrastructure

The Inuvik site has groundside access consisting of gravel roadways on the north. This roadway connects to the main airport development and onwards to the townsite via the Dempster Highway.

Electrical power is available from NWTPC and is considered to be adequate.

There are no deficiencies associated with the airport's telecommunications system. Potable water is hauled by truck from the townsite and stored in tanks within the various airport buildings. There is no central sewage system and each airport tenant has to depend on their own holding tank for sewage collection and disposal.

The storm water run-off is accommodated through a series of ditches and culverts from the north side development and should be sufficient for the hangar project development.

5.13 Norman Wells

a) Overview

The hamlet of Norman Wells is situated on the banks of the MacKenzie River, midway between the Alberta border and the Beaufort Sea. It is located at 65° 17' N and 126° 48' W.

Transportation access to Norman Wells is by water for cargo/freight in the summer. There is no all weather road access to Norman Wells.

The airport is classified as regional and serves as an enroute stop for thoroughfare along the MacKenzie Valley corridor. The majority of aircraft movements are itinerant commercial. Two major employers are the oil/gas sector and the airport.

b) Potential Site(s)

The airport development to date has been confined to the east half of the area located to the south of the runway with the heavy concentration being close to the terminal building. The area immediately west of the existing built-up area can be utilized for developing the aircraft maintenance facility. This area, running east-west, is restricted by the transitional height zoning from the runway, making for an inefficient building site configuration.

c) Expansion

The site at Norman Wells has very limited expansion capability because of the proximity of the runway, airport boundary and by the effects of the Runway azimuth 26 zoning restrictions.

d) Airside Infrastructure

A taxi stub from the existing apron would have to be extended to gain access to the development area. This would require some 250 m of extra taxiway in less than optimal soil conditions.

e) Landside Infrastructure

Access to groundside can easily be accomplished to any point south of the development. Commercial electrical supply is loaded to capacity and there is little spare capacity on the standby system. Natural gas is provided to the airport tenants and can be utilized for the development. Water and sewage systems need to be trucked in and out and stored in tanks on the site.

Cost Estimates

6.0 COST ESTIMATE

A budget framework for the implementation of the proposed facility has been estimated. These Class "D" estimates are as follows:

6.1 Capital Cost

The construction cost estimate has been itemized to reflect the various construction components, the effect of the geotechnical considerations for each site and the supply of fitments. The cost estimate includes consultant professional services, permits, insurance (if applicable), testing and site expenses in addition to the physical construction. The following table provides an overall comparison between the sites.

($ MILLION)

ITEM	Yellowknife (YZF)	Inuvik (YEV)	Ft. Smith (YSM)	Ft. Simpson (YFS)	Norman Wells (YVQ)	Hay River (YHY)
Base Building	5.20	6.80	5.40	5.60	6.40	5.20
Aircraft Apron	1.05	1.70	1.10	1.15	1.60	1.30
Infrastructure	1.55	-	0.55	-	1.10	0.55
Geotechnical Impact on Building	-	1.20	-	-	1.10	-
Geotechnical Impact on Site	0.50	0.85	-	-	0.80	-
Fitments	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL COST	8.55	10.80	7.30	7.00	11.05	7.30

NOTE:

1. Budget Costs are 1990 base.
2. It is recommended that a contingency allowance of 10% be carried in addition to the above budget costs.
3. The budget costs are based on project management implementation.

6.2 Operating and Maintenance Costs

An estimate of the average operating and maintenance costs for the facility, should it be located in Yellowknife, Fort Smith or Hay River, is as follows:

Operating Costs: \$30/m^2 (\$2.80/ft.^{2}) = \$120,300/Annum
Maintenance Costs: \$20/m^2 (\$1.85/ft.^{2}) = \$ 80,200/Annum

Operating costs consist of heating, power, water, sewer and insurance. Maintenance costs consist of janitorial, mechanical service contract and miscellaneous items.

The operating costs will increase approximately 20 - 30% for locations in Fort Simpson, Norman Wells and Inuvik.

NOTE:

1. The O & M costs do not include any Transport Canada lease costs.
2. GNWT management fees relating to a dry lease are not included.

Site Selection

7.0 SITE SELECTION

The site selection matrix below identifies both the technical and socio-economic aspects related to the implementation of an aircraft maintenance facility at the six communities. Each item has been weighted in accordance with the importance associated to it.

CRITERIA	WEIGHT	COMMUNITY					
	%	Yellowknife (YZF)	Inuvik (YEV)	Ft. Smith (YSM)	Ft. Simpson (YFS)	Norman Wells (YVQ)	Hay River (YHY)
Cost	30	90	60	150	180	30	150
Socio-Economic	25	150	75	125	50	25	105
Technical Complexity	5	25	5	30	20	10	15
Expansion Capability	5	20	5	25	30	10	15
Airside Infrastructure	10	20	60	40	50	10	30
Landside Infrastructure	5	25	15	30	10	10	20
Training	5	25	20	30	5	5	10
Strategic Location	15	90	45	75	30	15	60
TOTAL		445	285	505	375	115	405
Ranking		2	5	1	4	6	3

The rankings clearly indicate that Fort Smith is the recommended location for the implementation of such a facility.

Analysis of Contract Maintenance Operations in Edmonton

8.0 ANALYSIS OF EXISTING CONTRACT MAINTENANCE OPERATIONS IN EDMONTON (Status Quo Alternative)

8.1 Introduction

Heavy maintenance for the GNWT Fire Operations Program's airfleet is currently being carried out in a leased facility located at the Edmonton Municipal Airport, under contract to Conair.

This section of the Study first evaluates the existing facility in Edmonton in terms spatial requirements, structural constraints and electrical/mechanical systems. The implications of maintaining the status quo maintenance operation in Edmonton are then examined.

8.2 Spatial Requirements

Conair maintains the GNWT airfleet in building No. 39, located at the western boundary of the Edmonton Municipal Airport.

The work is concentrated in the north section of the facility which measures 128 feet wide by 250 feet long.

The inside clear width of the hangar is approximately 125 feet. This distance is just sufficient to house a DC-6 leaving only 3 feet clearance on either wing tip.

It should be noted that the hangar is unable to accommodate aircraft larger than a DC-6. Should the GNWT deploy the Hercules L-100-30 in the future, the 133 foot span of this aircraft will preclude its being serviced in this facility.

The 40 feet vertical clearance is sufficient for the existing fleet, however, it will be insufficient for larger aircraft.

Approximately 2,000 square feet of shop space and 1200 square feet of office space are currently being used by Conair. The balance of Conair's shops and administrative operations are located in Abbotsford. This space is insufficient for a centralized maintenance operation currently being considered by the GNWT. Minimum requirements would be in the order of 7800 ft.^{2} for support facilities plus additional space for administrative functions.

8.3 Structure

The building is constructed of conventional steel columns and roof trusses and is 15 - 20 years old. The building is non-insulated and without windows. This lack of natural light coupled with relatively low-levels of artificial light and limited infrared heating makes for a less than ideal working environment, particularly in winter.

The hangar doors are electrically operated and appear to be sound. Several of the door seals have deteriorated and should be replaced.

The concrete floor is extensively cracked. A centre trench drain runs the length of the hangar. This style of drain is no longer used in hangar design due to the tendency to propagate fires in the event of an oil or gasoline spill. Multiple drains that limit fire exposure to a particular area of the hangar are preferred.

The roof system, although not inspected, would appear to be deteriorating as evidenced by multiple water leaks in the hangar.

8.4 Electrical/Mechanical

Overall electrical capacity for the facility is adequate however, supply within the building lacks reliability due to circuit overloading and the shorting due to the water problems mentioned above. Both low voltage and high voltage supply (3 outlets) are available.

The hangar suffers from poor ventilation when the doors are closed due to a limited number of exhaust fans and associated make-up air units. Gasoline vapour concentration can be a problem when aircraft are being moved or serviced.

Infrared heating units are suspended from the roof trusses. Heating capacity appears to be limited due to the long recovery time (2-3 hours) experienced once the doors have been opened and closed in winter.

8.5 Operating and Maintenance Costs

From the foregoing discussion, it can be seen that the existing Edmonton operation is being conducted in an undersized, below standard facility that is unsuitable for the long term maintenance requirements of the GNWT airfleet. In order to maintain the status quo in Edmonton, i.e. sub-contracted maintenance, it will be necessary for the maintenance operation to be moved to a newer, larger facility. Conceivably, a new facility could be leased by the GNWT at the Edmonton International Airport who in turn would lease the space to the maintenance contractor. Other airports could also be considered but would depend on the successful contractor.

A comparison of projected operating and maintenance costs between a facility in Edmonton (YEG) and a facility in Fort Smith (YSM) are as follows:

FIGURE 8.0 - OPERATING AND MAINTENANCE COST COMPARISON

	YEG	YSM
Operating Costs		
Utilities	$ 72,000.	$ 120,000.
Transport Canada Ground Lease	15,000. $(\$1.20/\mathrm{m}^2)$	3,500. $(\$0.28/\mathrm{m}^2)$
Total Operating	$ 87,000.	$ 123,500.
Maintenance Costs		
Airport Maintenance Costs	$ 5,400. $(\$0.43/\mathrm{m}^2)$	$ 3,000. $(\$0.24/\mathrm{m}^2)$
Maintenance Services	$ 70,000.	$ 80,000.
Total Maintenance	$ 75,400.	$ 83,000.
Management Fee	$ 10,000.	$ -
Total O & M Expense (per annum)	$ 172,400.	$ 206,500.

Note: 1. These figures are for comparative purposes only and do not include financing costs.

It may be seen that overall O & M costs are approximately 20% less in an Edmonton based operation. There are however, a number of other factors that should be considered in evaluating the long term viability of an Edmonton based maintenance operation.

First, the long distance between the current administrative centre in Fort Smith and the heavy maintenance operation in Edmonton can lead to higher contract administration costs and more difficult quality control. Virtually all airlines and other fleet operators locate their administrative and maintenance functions in close proximity to one another to take advantage of economies of scale and to improve control of their operations.

Second, due to the condition of the existing hangar, the working conditions in winter are far from ideal. The use of a modern, fully equipped facility would ensure improved working conditions and a high level of quality control. This improvement in turn, leads to enhanced safety and reliability in aircraft operations.

Third, opportunities to earn revenue from third party maintenance is not available in Edmonton as this revenue now flows to Conair.

Fourth, the existing hangar is undersized and unable to accommodate aircraft larger than a DC-6. Acquisition of larger aircraft in future, such as the L-100-30, would further limit the utility of this hangar.

8.6 Summary

If the Edmonton location were added to the site selection matrix previously presented in Figure 7.1, it would score approximately 400, ranking it middle of the scores for the other NWT communities. Fort Smith, Yellowknife and Hay River still score higher when the key factors of cost, socio-economic benefit and strategic location are taken into account.

It is concluded, therefore, that the current heavy maintenance operation in Edmonton, while remaining feasible for the short term, is not a viable operation for the long term GNWT airfleet maintenance requirements. The operation should be re-located to the NWT and centralized with the administrative function.

When all the key technical, logistic and socio-economic factors are considered, Fort Smith would be the recommended location where the maximum benefits from the facility construction and on-going operation will be realized.

Space Planning

9.0 SPACE PLANNING

This section of the report identifies building design parameters for the new facility.

Space planning considerations are based on the premise that the proposed facility will centralize the Government of the Northwest Territories' Fire Operations Air Tanker Maintenance operations. More specifically, the new facility will house the administration functions and provide the hangar and specialized maintenance shop space required by a sub-contractor to maintain the GNWT's contracted airfleet.

In order to assess the GNWT's needs, the three general areas of the operation will be considered and addressed separately. These are the hangar, support facilities and administration. The analysis and recommendations are based on information contained in the RFP, discussions with GNWT personnel, a review of the Edmonton hangar and a comparison of the operations of other hangar bases at Wardair, Pratt and Whitney, Worldways, Ontario Ministry of Natural Resources, First Air, Skycharter and Echo Bay Mines.

9.1 Hangars

In order to recognize the requirements of the GNWT's sub-contracted maintenance program, the various classes or levels of scheduled maintenance checks must be understood. Table 9.1 lists the various class checks required and includes a brief description of each, the maximum flight time interval at which checks must be carried out, and the approximate hangar time required for each class of check. For the anticipated fleet of four aircraft (excluding the Piper Aerostars), it should be noted that with proper maintenance scheduling only one "C" check will be required each year. All work time is based on a single eight hour shift.

The compressed maintenance season of September to April yields an approximate

TABLE 9.1 - SCHEDULED MAINTENANCE CHECKS INFORMATION

CHECK CLASS	MAXIMUM INTERVAL (Flight Hours)	MINIMUM HANGAR WEEKS (per aircraft)	BRIEF DESCRIPTION	HANGAR WEEKS TOTAL FLEET
CL-215				
A	N/A	Field Operation	General inspections of structure and engine, check fluid levels, execute repairs where required.	-
B	300 or annually	5	As for "A" check, plus opening of engine and systems panels; change filters; more detailed examination; repairs where required.	5.0
C	5000 or every 6 years	12	Major mechanical check, all systems, noting amount of wear; check controls; repair interior; check for corrosion and cracking; repair as required.	12.0
Unscheduled		1.0	Including hangar time as required on an ongoing, daily basis for unscheduled repairs as a result of component irregularities or failures; general cleaning and maintenance; unscheduled engine changes; spring training exercises.	2.0
TOTALS				19.0 weeks

TABLE 9.1 - SCHEDULED MAINTENANCE CHECKS INFORMATION (Continued)

CHECK CLASS	MAXIMUM INTERVAL (Flight Hours)	MINIMUM HANGAR WEEKS (per aircraft)	BRIEF DESCRIPTION	HANGAR WEEKS TOTAL FLEET
DC-6/L-100-30				
A	N/A	Field Operation	General inspections of structure and engine, check fluid levels, execute repairs where required.	-
B	300 or annually	5	As for "A" check, plus opening of engine and systems panels; change filters; more detailed examination; repairs where required.	10.0
C	5000 or every 6 years	12	Major mechanical check, all systems, noting amount of wear; check controls; repair interior; check for corrosion and cracking; repair as required.	-
Unscheduled	'	1.0	Including hangar time as required on an ongoing, daily basis for unscheduled repairs as a result of component irregularities or failures; general cleaning and maintenance; unscheduled engine changes; spring training exercises.	2.0
TOTALS				12.0 weeks

maximum time period of 30 weeks. Using the values and the data of Table 9.1, it can be determined that hangarage is required for 31 weeks. However, due to the nature of the work carried out on the CL-215's and the DC-6's, part supply can be an issue and hence "perfect" hangar utilization is not feasible, thus considerably reducing the available hangar weeks. In addition, the extended fire season may restrict the available weeks for maintenance. It is therefore recommended that provision be made to accommodate one CL-215 and one DC-6 aircraft simultaneously. Since the future replacement aircraft for the DC-6 is expected to be the Hercules L-100-30, spacing for the hangar should accommodate the Hercules, being the larger of the two types.

In terms of the Piper Aerostar aircraft, scheduled maintenance to one of these aircraft will be required when CL-215 and DC-6 aircraft are also being maintained, and therefore, space provision must also be allocated for a minimum of one of these aircraft. It should be noted that due to the size and shape of the large aircraft, these smaller aircraft can be positioned within the facility simultaneously.

Clearly from the above analysis, the size of the facility is driven by the size and number of aircraft and it is concluded that the minimum hangarage must accommodate one (1) CL-215 and one (1) Hercules L-100-30 (as a possible replacement for the DC-6 fleet) in addition to miscellaneous equipment, at any one time.

Three layout scenarios have been presented (see Appendix 'A') and evaluated in addition to the GNWT's concept as outlined in the proposal call. Option 2 has been deleted from further consideration due to the significant increase in floor area when compared with the other options. The recommended plan has been developed to accommodate both Option 1 and 2 in the light of comments received during the Interim report briefing and on experience gained with similar projects.

9.2 Support Facilities

Shop maintenance staff of 10 is estimated to be needed for specialized "support" services for the aircraft. The following list of support facilities and areas is required and is based on a review of the existing facility at the Edmonton Municipal Airport hanger and discussions with maintenance personnel. Proposed facilities and area designations also reflect those of other aircraft maintenance operators referred to in the aforementioned.

TABLE 9.2

SUPPORT FACILITIES:	AREA (m^2)	AREA ($ft.^2$)
Cleaning/Degreasing	9	100
Paint	28	300
Sheet Metal/Welding	46	500
Machine	46	500
QEC	56	600
Avionics/Electrical Accessories	46	500
Battery	5	50
NDT	23	250
Mechanical/Electrical	37	400
Stores		
- shipping/receiving	93	1,000
- flammable stores	28	300
- purchasing office	19	200
- main stores	279	3000
- wheel storage	9	100
- quarantine and unserviceable parts (on hangar floor)	-	-
TOTAL:	**724 m^3**	**7,800 $ft.^3$**

In discussions with Canadair, it was noted that they stock consumables and maintenance items in low quantities available on 24 hours notice and that airframe parts are only manufactured on request. However, it was also recommended by Canadair that owners should keep a full supply of parts for their aircraft or alternatively, participate in a parts pool with other Canadian CL-215 operators.

In summarizing, it is recommended that a full range of spare parts should be stored but in limited quantities where these are readily available from distributors in major centres or the manufacturer.

Stores in other commercial aircraft maintenance facilities are generally smaller in area as their fleets are not as diversified and parts are more readily available throughout the aviation marketplace due to the high number of aircraft manufactured of a particular type.

It is suggested, due to the type of material to be stocked in the stores, that a single tier system be adopted. Storage of large articles can be accommodated on the hangar floor area.

It should be noted that a number of facilities have been modified or added to the spatial analysis provided in the original Proposal Call. It is our opinion that the facilities proposed in this Feasibility Study are necessary and compare well with other operators. Other related support facilities that are found at other airlines include ground support equipment maintenance, upholstery, safety equipment, brakes, fibreglass shops and commissary. These are not considered essential for the GNWT operation, but could be considered if the fleet grows in size significantly.

9.3 Administration

The administrative section is estimated to employ 5 staff. The office portion is divided into administration and aviation maintenance. The following table lists the office as well as other administrative functions, and the areas required for each.

TABLE 9.3

FUNCTION	AREA m²	(ft.²)
Administration Offices	120	1300
Maintenance Office/Library/Inspection Officer	56	600
Flight Operations Office	14	150
Boardroom/Training Room	28	300
Office Storage	9	100
Lunchroom	46	500
Washrooms/Janitors closet	46	500
Lobby/Corridor	56	600
First Aid	5	50
Gov't Liaison Office	14	150
Base Manager Office	14	150
TOTAL	408 m²	4,400 ft.²

Building Description

10.0 BUILDING DESCRIPTION

10.1 National Building Code

The building classification adopted for the design program is as follows:

N.B.C. Classification
Group F, Division 2, Clause 3.2.2.52
Unsprinklered, 1 storey, facing 3 streets
Gross floor area less than 4800 sq. meters
Non-combustible construction

Based on this criteria, the implementation of sophisticated fire suppression systems is not mandatory and is therefore subject to GNWT internal policy. A further discussion on fire protection systems is dealt with separately in this report.

10.2 Floor Areas

It has been determined in the space planning analysis that a hangar capable of housing one (1) CL-215 water bomber and one (1) DC-6 is required for the present. The analysis has been carried out without consideration to the hangar time requirements of other aircraft and the storage of items such as engine stands, fork lifts, and other miscellaneous equipment. However, it is evident from the recommended generic facility floor plan that sufficient floor space exists for these items.

The shop areas should all be accessible at ground level in addition to the administrative functions. The construction of a second level in the shop/office area is not suggested as many administrative functions provide direct support to the hangar operations.

A summary of the floor areas is as follows:

FUNCTION	AREA m²	AREA ft.²
Hangar	2997	32260
Support Services	724	7800
Administrative Offices	408	4400
Total Facility Area	4129	44460

10.3 Building Clearances

a) Hangar

The hangar clearances provided between aircraft and fixed objects are based on 2400 mm (8 ft.). For vertical clearances there are a number of factors that need to be considered which have an influence not only on the door height but also on the overall building height. They include:

- Structural frame deflection under dead and live loading
- Under-running bridge cranes supported from the structural frame
- Aircraft jacking
- Collapsed aircraft nosewheel
- Nominal clearance of 300 mm (12")

Taking into consideration all of the above factors, the following design criteria have been established:

Building width	51.80 m	(170 ft)
Building length	57.30 m	(188 ft)
Building eave height	14.65 m	(48 ft)

Building peak height	15.25 m	(50 ft)
Hangar door height	12.50 m	(41 ft)

Roof slope approx. 1 in 48

b) Support and Office Facilities

These areas are to be provided with the following minimum vertical clearances:

Maintenance Shops	3000 mm	(10 ft)
Offices	2600 mm	(8.5 ft)

10.4 Special Considerations

a) Foundations

The existing soil conditions encountered at each site are dealt with in Appendix "B" of this report.

We suggest that a geotechnical investigation be arranged during the design phase at which time the following items can be determined:

- The extent of permafrost (if any);
- Allowable bearing capacity for spread footings, or perhaps piles;
- CBR test results for new apron construction.

b) Structural Steel

Pre-engineered structural steel has been extensively used in the recent construction of many hangars. Its use has resulted in lower capital costs and reduced hangar volumes when compared to conventional truss design. This translates into reduced maintenance and heating costs. Pre-engineered buildings also take less time to fabricate and erect. We recommend that this proven approach be adopted.

c) Cranes

Due to the high cost of providing a crane to cover the entire hangar floor area and its low utilization time, it is suggested that the hangar area only be provided with crane coverage for engine overhauling. Considering the fact that either one DC-6 or CL-215 may be in for a "C" check, it is suggested that coverage be provided in between grids F and H over the full width of the hangar. The crane should be designed for a capacity of 5 tons.

Any other miscellaneous work requiring cranage can be accommodated by the use of mobile gantry cranes, which can also be used outside on the ramp. The work area encompassing the machine and QEC shop areas should be serviced by an 1 ton overhead monorail hoist.

Both of the aforementioned cranes have been included in the capital cost estimates.

d) Fire Protection

The installation of an Aqueous Foam Forming Film (AFFF) fire protection system could be considered for this facility considering the type of aircraft that may be in the new hangar at any one time and the type of fire program the GNWT is involved with.

The type of protection afforded by this system can range from an overhead foam sprinkler system with handlines at ground level to an overhead foam sprinkler system with oscillating monitors and visual detection system. Costs associated with such a system are in the order of one million dollars ($1,000,000).

Water supply is the main concern as the flow and pressure requirements are not available on any of the sites. To solve this, an in-house reservoir would be required in addition to a pumphouse with two or three diesel pumps depending on the scheme chosen. Disposal of the spent AFFF would also create problems as sewage systems are limited.

It is recommended that the GNWT carefully consider these options noting that under the N.B.C. Classification for this building this type of system is not required. The costs of such systems have not been included in the cost estimate.

The requirement for fire hydrants located around the building perimeter has been reviewed. In accordance with the N.B.C. and the Fire Underwriters Survey on water supply for public fire protection, the water supply must be capable of supply 12000 litres/min (2600 GPM) for a duration of 1 hour. This water supply is not presently available.

It is recommended that discussions be held among the GNWT, Transport Canada, the local Building authority and the design consultant to determine the level of exterior fire protection that would be deemed acceptable for the project, once the site and design parameters are finalized.

10.5 Facilities Specifications

Outline specifications for each area in the new facility are included in Appendix C.

10.6 Durability and Warranties of Construction Materials

The durability and warranties of construction materials and techniques are described under the following headings:

1. Building Envelope - Hangar
2. Building Envelope - Shops/Offices
3. Building Structure
4. Warranties

It shall be noted that this evaluation is in no way intended to restrict the choice of either material or construction techniques.

a) Building Envelope - Hangar

One of the most important elements of concern when designing and constructing buildings in the North is the exterior skin of the building which completely encapsulates the entire building structure while protecting the interior environment from the harsh climatic conditions of the North.

In practical terms, the materials and construction techniques have been limited to exclude wood products, masonry and precast concrete. Wood products have been excluded due to combustibility and maintenance. Masonry products have been excluded due to lengthy construction processes in a limited construction period as well as problems in transporting, placing and cost. Precast concrete products have been excluded due to expensive transportation costs and high component costs.

The building envelope is therefore limited to two cladding systems. These are factory prefabricated panel systems and conventional built-up cladding systems.

The factory prefabricated panel systems consists of two prefinished metal skins which sandwich a foam insulation. The inner and outer skins of the system are 20 or 22 gauged galvanized steel with a factory applied barrier type coating applied to the exposed faces of the steel. The skin edges are rolled to suit the interlocking joints of the panel. The two metal skins are then aligned on rollers and spaced several inches apart depending on the required thermal properties of the panel. Liquid polyurethane is then applied by machine to bottom skin and a blowing agent is applied to cause the liquid to foam up to the primed inner face of the top panel. A Class 1 Type Polyurethane is recommended for this process since it has a tight cell structure, uniform density and excellent "string time". The entire panel is fabricated in a controlled factory environment and shipped to the site for erection. On site the panels are secured to a girt sub-framing system. The panel's interlocking joints receive silicone caulking and associated gaskets in order to provide the effective double seal technique required for an effective watertight envelope. These panels are used for both the walls and the roof portions of the building. Roof joints receive additional battens and gasketing in order to provide a practical deterrent to the elements.

The conventional built-up system is the most widely used in the North because it was developed long before the prefabricated systems were in place. The built-up system consists of an assembly of different construction materials that are sequentially erected to form a building envelope. The rolled glass fibre insulation with its integral vapour retarder is placed over the purlin or girt sub-framing members. Continuous strips of rigid insulation are then fastened over the glass fibre blanket to act as thermal blocks and reduce thermal bridging. The outer metal skin of prefinished galvanized cladding is secured through the insulation layers and to the sub-framing. The joints of the outer skin are caulked in order to provide an effective barrier. The joints of the roof panel are interlocking or seamed in order to provide an additional deterrent to the elements. The inner face of the built-up system can be left as an exposed vapour retarder or by the use of offset furring, can be clad with metal liner or drywall.

The factory prefabricated panel system is a superior product as it provides a better building envelope, however it is also much more expensive than built-up systems. The advantages of the built-up system are as follows:

1. the capital cost of the system is lower.
2. if the outer and inner skin expand and contract at different rates there is no problem of delamination or bowing.
3. a proven track record of successful installations.
4. this system uses noncombustible components and therefore has increased fire safety.
5. uses standard fabricated materials with quick replacement time.

b) Building Envelope - Shops/Office

In order to provide architectural relief and more interesting features to a predominantly metal clad building, the shops and offices are proposed to be treated with both horizontal and vertical cladding profiles. In order to achieve the directional features, the construction of the wall system must change to metal stud infill framing. This also compliments the variety of finishes required between the shops and office functions. The windows will be nominally sized punched units since large spans of strip windows are not very efficient in the North. The roofing system can be either standing seam like the hangar or a modified bitumen roofing system.

c) Building Structure

Almost all hangars in Canada are structural steel framed buildings. This is especially a necessity for northern hangars where significant snow loads combined with the wide building spans make any other structure types uneconomical and ineffective.

Two types of steel structures could be considered - rigid frame, and conventional truss. The rigid frame takes advantages of the building shape and geometry and makes for a more efficient structure. The conventional steel truss is a heavier design requiring much more roof space and volume and is therefore, more costly. We therefore recommended as rigid-frame steel structure for the hangar buildings.

d) **Warranties**

All warranties for material, equipment, and installations are for a period of 12 months which is standard in the construction industry. Deviations from this 1 year guarantee period are with the roof systems where 2 year warranty for modified bitumen roofing and a 20 year guarantee for the standing seam roof are available. The warranty on the metal clad wall systems will vary with the specific finish chosen as many types are available, some with a cost premium.

Purchase vs. Lease Analysis

11.0 PURCHASE, LEASE AND LEASE PURCHASE ECONOMIC ANALYSIS

11.1 Introduction

This section analyzes three financing options for the new facility as specified in the Terms of Reference - purchase, lease and lease to purchase.

It should be noted that the maximum lease term currently available for a project of this nature is 10 years. As a result, the second option - renewable lease on set increments (for the life of the facility) - is limited to a 10 year term and is thus identical to the lease to purchase scenario. In other words, the cumulative monthly lease payments in a straight lease will have effectively paid for the facility by the end of year 10.

This section therefore provides a pro-forma cost statement (see 11.3) and comparison of the purchase versus lease-to-purchase methods of acquisition (see Figure 11.1). When interpreting the pro-forma cost statement and purchase versus lease comparison, the reader should refer to section 11.4 "Notes and Summary of Significant Assumptions", in addition to the following general comments:

a) Figures in the Pro-Forma Cost Statement are in 1990 dollars.

b) Under the purchase options, it is assumed that the GNWT could obtain 100% construction and permanent financing at an interest rate of 13%.

c) Should a leasing option be selected, the effective interest rate at this time would be approximately 13.2% for lease to own and 12.85% for lease to own with 15% buy-out.

d) Leasing is a form of debt financing which typically provides greater financial leverage than conventional debt financing. As the cost of money under debt financing is usually greater than with equity financing the GNWT should weigh whether it places any value on the use of leverage for this project.

e) The analysis utilizes a 10 year projection period as the longest lease term currently available for a project of this nature is 120 months. In order to provide a common basis for comparison purposes the purchase projections were confined to the 10 year time frame.

11.2 Recommended Acquisition Option

On a total present value basis, the most cost effective option to finance the facility would be for the GNWT to pay for the capital costs during the construction period. Should the GNWT decide to lease, then leasing to own with a 15% purchase option would be the most cost effective lease. An earlier buy would make this option even more attractive. (see "Notes and Summary of Significant Assumptions").

11.3 Pro-Forma Cost Statement

Capital Costs	
All-in capital costs	$ 7,300,000.
Operating Costs	
Transport Canada Ground Lease (YSM)	3,500.
Utilities & Fees	55,100.
Total Operating Costs	$ 123,800. Per Annum
Maintenance Costs	
Airport Maintenance Cost (YSM)	$ 3,000.
Maintenance Services	80,200.
Total Maintenance Costs	$ 83,200. Per Annum
Total Expenses	$ 207,500. Per Annum

NOTE: The O & M costs do not include management fees relating to an operating lease.

11.4 Notes and Summary of Significant Assumptions

Pro-Forma Cost Statement

1. The actual all-in capital costs will be influenced by such factors as project timing, construction methods, and force majeure.

Purchase Option "A"

1. Capital costs are funded through an interim construction loan bearing interest at 13% on the outstanding principal drawn down during the construction period.
2. At the end of the 12 month construction period the GNWT pays out the principal and interest.

Purchase Option "B"

1. Capital costs are funded as in "A", however, a conventional mortgage is used to pay out the interim construction loan:

Principal:	$8,100,000
Interest:	13%
Amortization Period:	10 Years

Equal monthly blended payments on account of principal and interest: $120,940.

Purchase Option "C"

1. The GNWT funds the capital costs during the construction period as they are incurred with cash equity.

Lease Option "A"

1. The GNWT leases the premises at $110,000 per month, and at the end of year 10 ownership is transferred to the GNWT for $1.00.

Lease Option "B"

1. The GNWT leases the premises at $103,916 per month, and at the end of year 10 purchases the Premises for $1,095,000.00

Lease Option "C"

1. The GNWT leases the premises according to a "stepped" payment schedule:

6 months @ $ 25,000 per month
12 months @ $ 75,000 per month
36 months @ $100,000 per month
66 months @ $152,000 per month

At the end of year 10 ownership is transferred to the GNWT for $1.00.

Purchase versus Lease Comparison

1. "Total Payments by GNWT" includes operating and maintenance costs.
2. An average annual inflation rate of 5% is applied to operating and maintenance costs.
3. Leases would be on a net, net, net basis with operating and maintenance costs charged back to the GNWT.
4. Amounts are rounded to the nearest dollar.
5. A discount rate of 13% was used in the present value calculations.
6. Under the purchase options the present value calculations did not incorporate

any projected asset value at the end of the comparison period. For example, if the assets were sold at the end of year 10, the total present value of the GNWT's payments would be reduced.

7. Savings from deductible expenses which may apply to the GNWT's accounting for this project are not incorporated into the present value calculations.

8. All the lease options have been based on a capital cost of $7,300,000. The lessor's equity financing costs during the construction period, if any, have not been included. These costs will increase the present value figures for the lease options only.

9. The decision to borrow or lease is a financing question that should select the payment option with the lowest payments on a total present value basis. Other factors that may influence the lease or buy decisions are:

    a) Does the amount of the monthly payments matter? For example, if the facility is costed for as a profit centre there may be an upside monthly payment amount which cannot be exceeded.

    b) Accounting Criteria: The GNWT should weigh whether there is any accounting related preference to increasing its assets without debt (Purchase Option "A" & "C"), with debt (Purchase Option "B"), and the manner in which the lease would be capitalized and the resulting effect on projects' financial statements.

    c) Ownership: If the GNWT does not want the responsibilities of ownership (management, repairs and maintenance) then leasing may be the preferred financing option depending on how the GNWT weighs the management responsibilities in its decision making process.

FIGURE 11.1 - Purchase Versus Lease Comparison

Purchase Options	Capital Payment By GNWT	Total Payments By GNWT	Total Present Value of Payments By GNWT
A. Interim Construction Loan, GNWT Pays out Interim Loan.	$8,100,000.	$11,474,100.	$9,488,170.
B. Interim Construction Loan, Conventional Mortgage	0	$17,886,900.	$9,636,019.
C. Equity Financing	$7,300,000.	$10,674,100.	$8,588,622.
Lease Options			
A. Lease to Own	-	$16,574,100.	$8,756,156.
B. Lease to Own with 15% Purchase Option	-	$15,844,020.	$8,649,200.
C. Stepped Lease	-	$17,906,100.	$8,755,819.

Note: In the lease option, buy-outs are available in 3, 5 or 6 years. These have the effect of improving the present value amounts proportionately i.e. earlier buy-out, lower present value.

Implementation Schedule

12.0 IMPLEMENTATION SCHEDULE

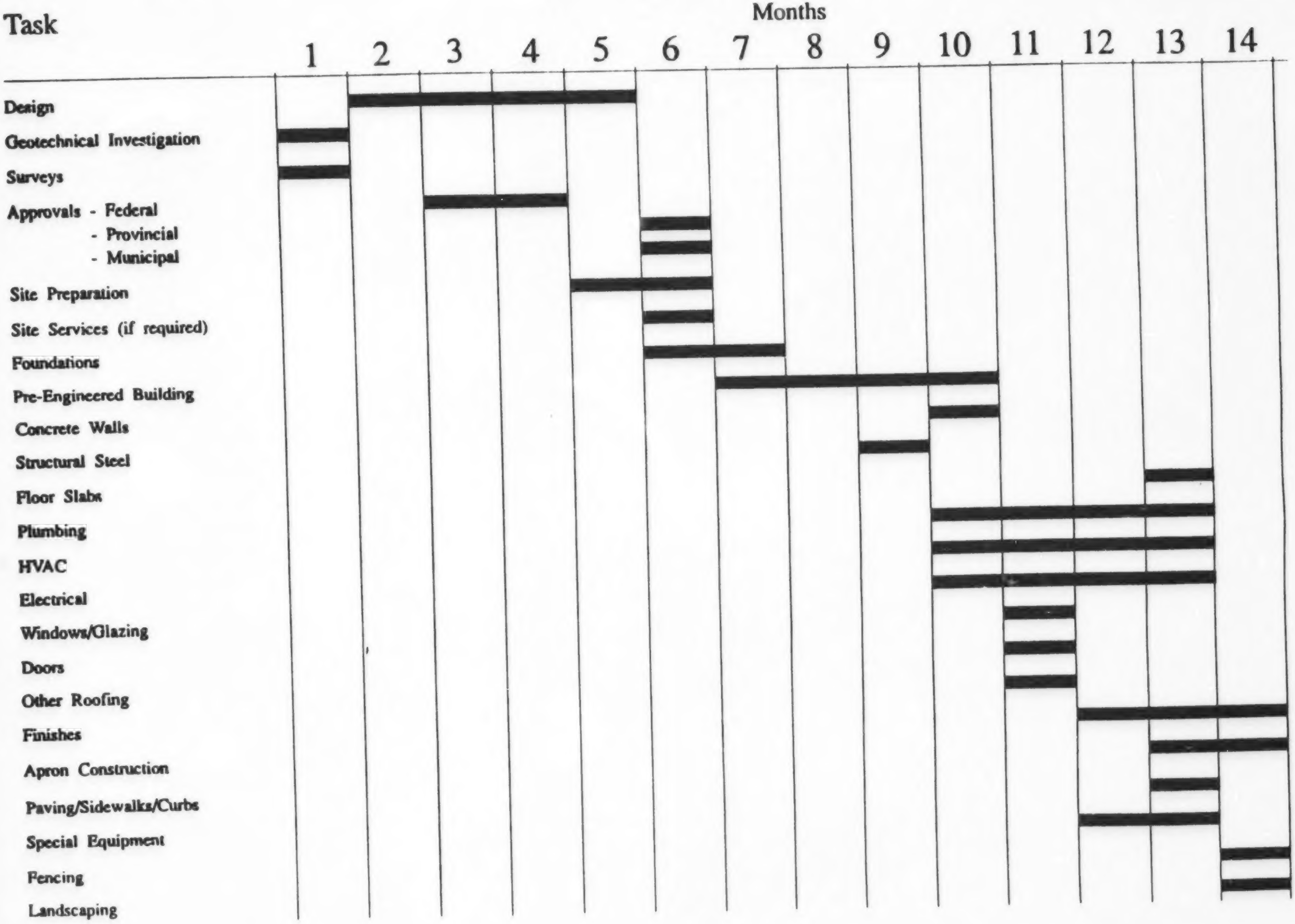
Figure 12.1 indicates the necessary tasks and time-frames required for the implementation of an aircraft maintenance facility, excluding any infrastructure construction that may be required as this is dependent on the site chosen.

The schedule is based on a project management approach so that tendering and construction of the work may be phased with the design.

FIGURE 12.1

IMPLEMENTATION SCHEDULE

(Project Management Approach)



Consultant/ Construction Services

13.0 CONSULTANT/CONSTRUCTION SERVICES

The following list provides a brief outline of the services required for the construction of this facility:

Design and Engineering
Project Management
Site Supervision
Site Preparation
Site Services
Paving/Sidewalks/Curbs
Landscaping
Fencing
Foundations
Concrete Walls
Concrete Floor Slabs
Pre-engineered Building c/w Hangar Door
Structural Miscellaneous Steel
Plumbing
HVAC
Electrical
Windows/Glazing
Doors c/w Hardware
Other Roofing

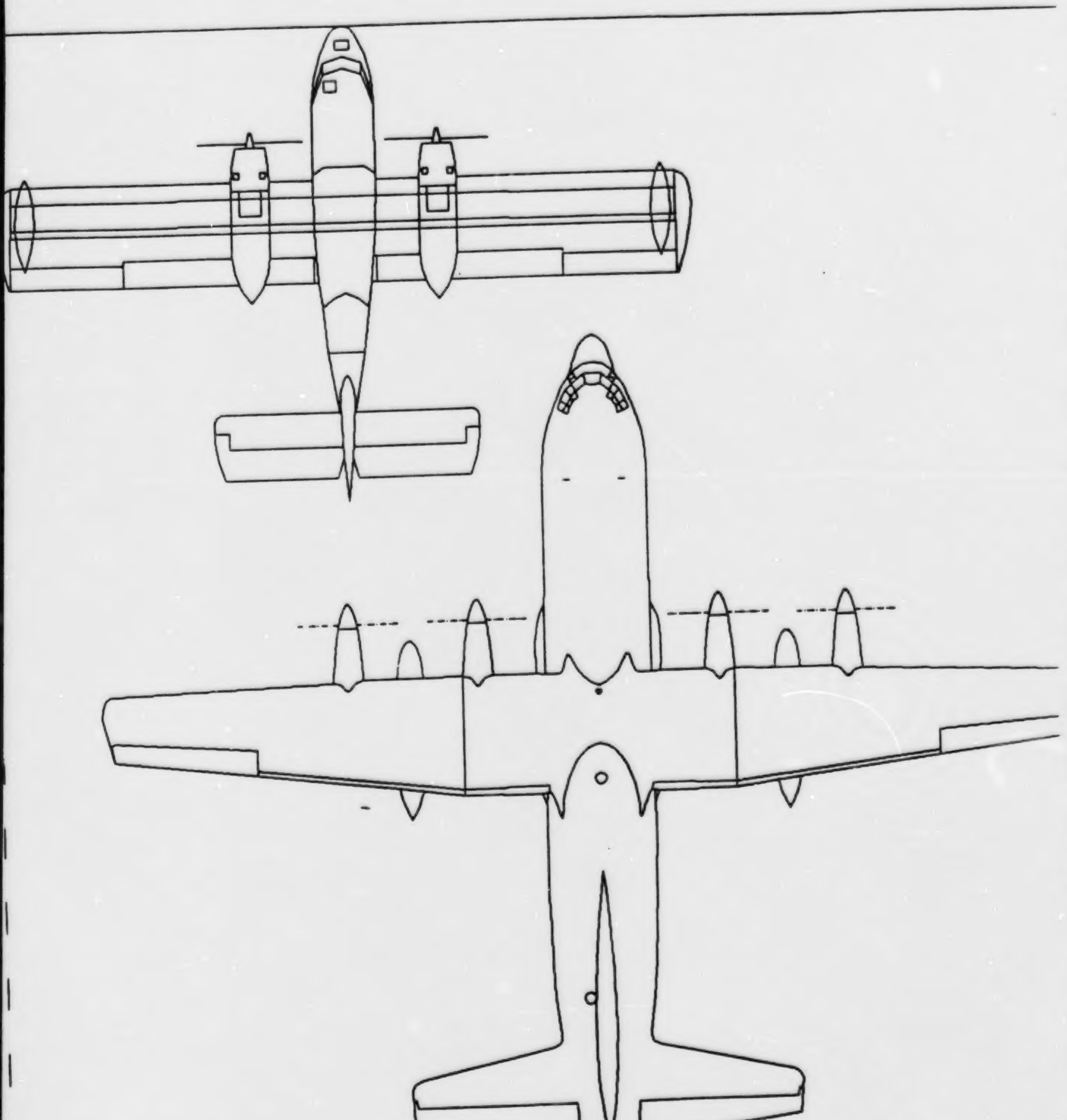
Finishes - Drywall/Acoustic Tile
Painting
Carpentry
Carpet/VAT
Ceramic Tiles
Washroom Accessories

Special Equipment - Loading Dock
Intrusion Alarm
P.A. System

A Hangar Utilization Alternatives

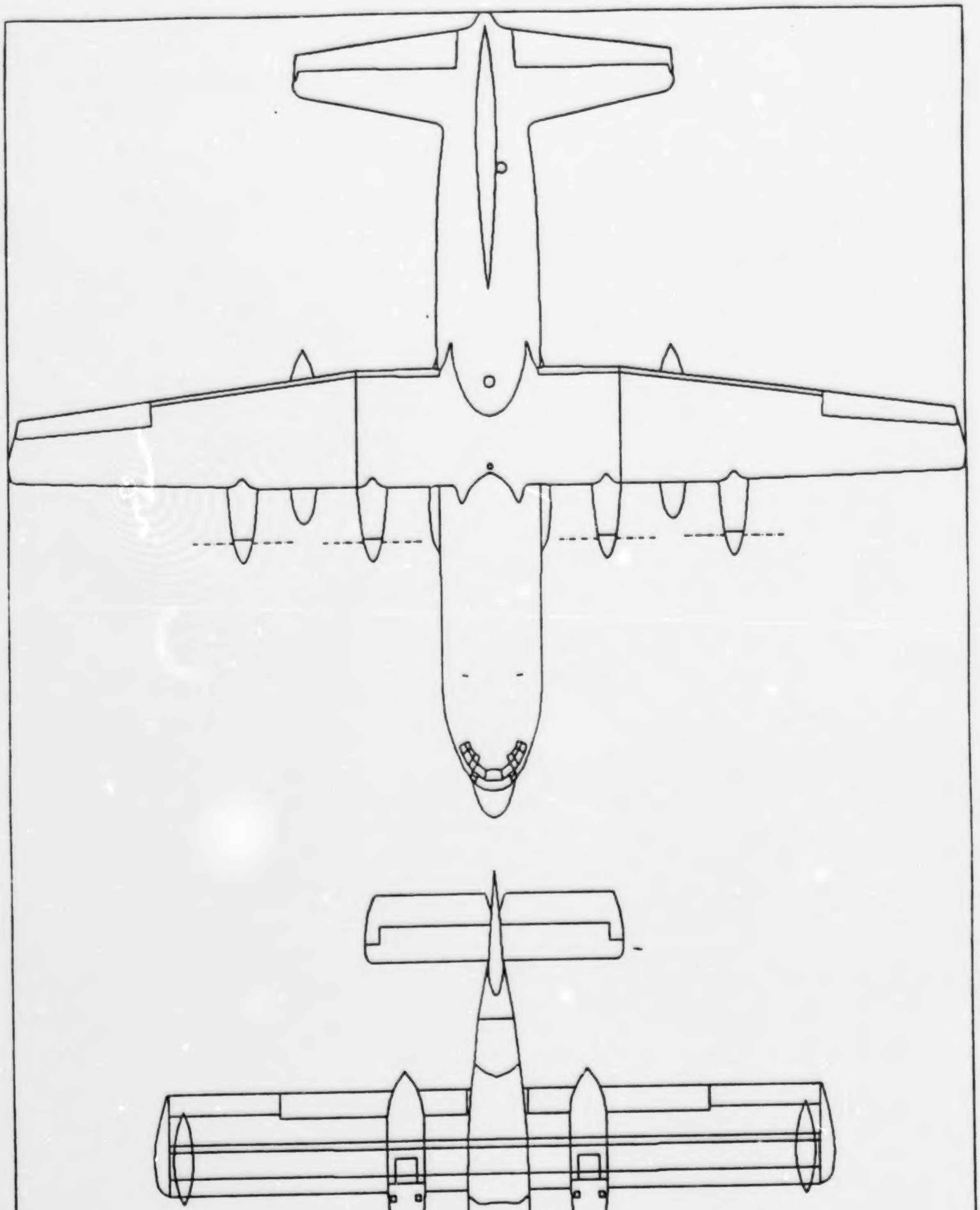
HANGAR UTILIZATION

Alternative 1



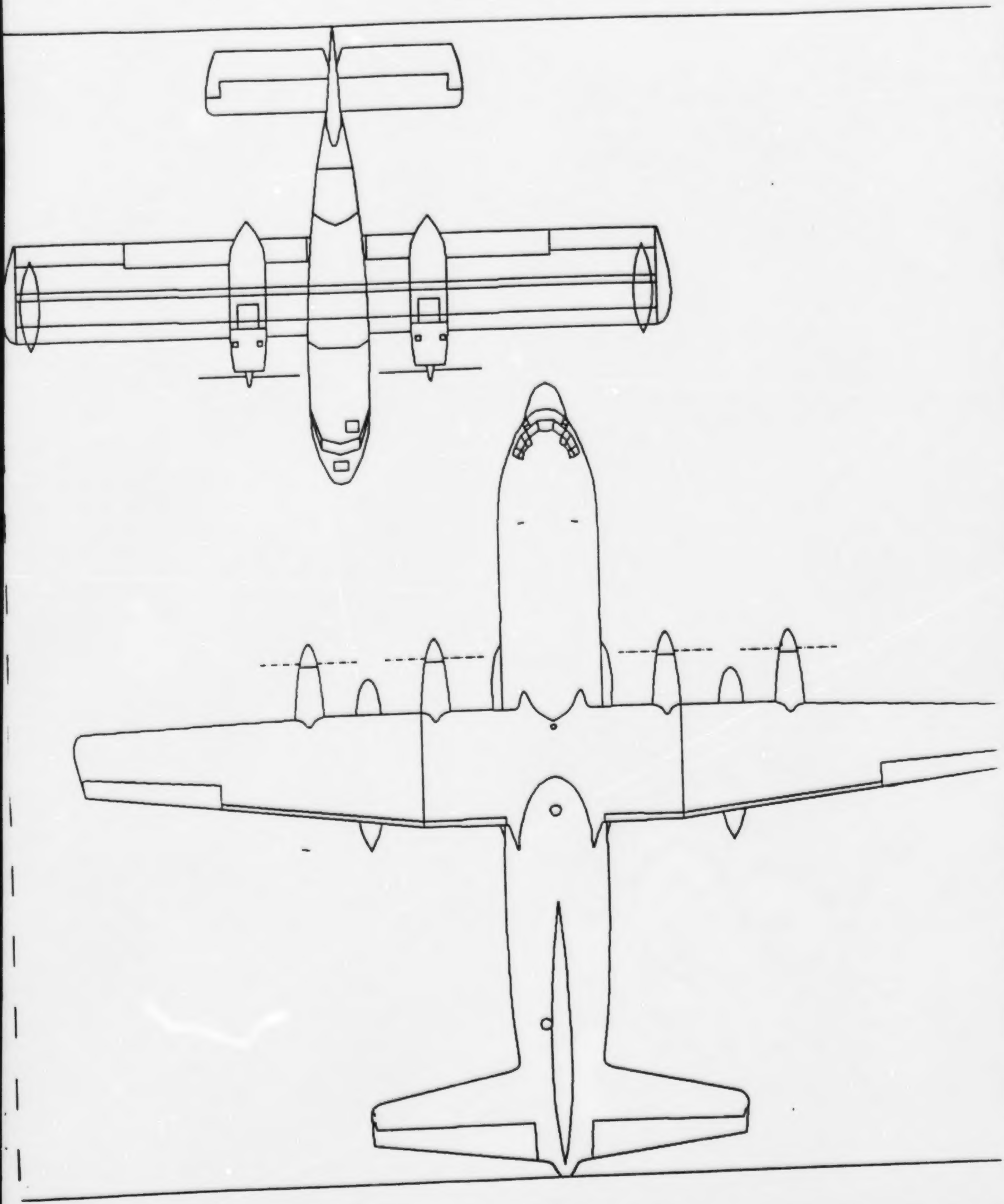
HANGAR UTILIZATION

Alternative 2



HANGAR UTILIZATION

Alternative 3



B Site Evaluations-Geotechnical

APPENDIX "B" - SITE EVALUATIONS - GEOTECHNICAL

YELLOWKNIFE AIRPORT

1.1 Site Conditions

Yellowknife is located in the discontinuous permafrost zone, on the north shore of Great Slave Lake.

Most of the area in the vicinity of the existing airport buildings has been cleared for many years. The areas are well drained and the near surface soils are trafficable to construction equipment during the thaw season.

The major soil units which are expected to underlie the proposed site include:

- silty sand,
- bedrock.

The proposed site is underlain by dense to very dense silty sand. The sand is moderately to highly susceptible to frost heaving. Frost heaving is not a major concern at this location however, since the depth of the groundwater table exceeds 5 metres. In contrast, frost heaving, as a result of a high water table, has caused maintenance problems for the shorter 09-27 (east-west) runway at Yellowknife Airport.

The sand is underlain by very hard granite bedrock. The bedrock surface is highly variable and could vary up to 20 m in depth below the site. Examination of the airphotos indicates that bedrock outcrops are present in the vicinity of, and possibly on, the proposed site.

Permafrost is generally absent in the vicinity of the existing airport buildings and is not likely to be present below the proposed site for the hangar.

1.2 Taxiways and Aprons

The site grading requirements will be controlled by existing topography and surface drainage.

For conceptual design it is recommended that the pavement structure consist of 125 mm of Hot Mix Asphaltic Concrete placed on 250 mm of crushed rock base. The total thickness of the sub-base, base and wearing surface should be at least 1 m. Care should be taken to ensure positive drainage of surface runoff away from pavement structures.

Paved surfaces are expected to perform satisfactorily and no significant post construction settlements or frost heaving are anticipated.

1.3 Hangar Foundations

The hangar would be founded on either a concrete raft foundation placed on a compacted gravel pad, or on a perimeter strip footing. A concrete slab on grade floor would be used with the strip footing.

The floor slab elevation should be set to ensure positive drainage of surface water away from the building.

There is some risk that bedrock may be encountered at shallow depth in footing excavations. If bedrock is present at shallow depth over a portion of the building area, it will be necessary to found all foundation elements on bedrock.

FORT SMITH AIRPORT

Fort Smith is located about 300 km south of Yellowknife and is located within the discontinuous permafrost zone.

2.1 Site Conditions

The site was originally treed with spruce trees. The area was cleared several decades ago when the runway was constructed at Fort Smith. The site is well drained and trafficable to construction equipment during the thaw season.

No test hole data was available in the vicinity of the airport. However, based on an examination of airphotos, and information from test holes drilled in the Town, it is expected that the following soil units are present below the proposed site:

- lacustrine deposits,
- bedrock.

The site is underlain by lacustrine deposits which most likely consist of compact, interbedded silty sands and silt.

The silty sands and silts are underlain at depth by granite bedrock. The depth to bedrock is not known, but probably exceeds 10 metres and may exceed 30 metres.

The depth of the groundwater table is not known but most likely exceeds about 2 m.

Permafrost is present in the vicinity of Fort Smith, primarily in poorly drained areas where peat is present. It is unlikely that permafrost is present below the proposed site for the maintenance facility.

2.2 Taxiways and Aprons

The site grading requirements will be controlled by existing topography and surface drainage.

For conceptual design it is recommended that the pavement structure consist of 125 mm of Hot Mix Asphaltic Concrete placed on 250 mm of crushed base. The total thickness of the sub-base, base and wearing surface should be least 1 m.

Care should be taken to ensure positive drainage of surface runoff away from pavement structures.

Paved surfaces are expected to perform satisfactorily and no significant post construction settlements or frost heaving are anticipated.

2.3 Hangar Foundations

The hangers could be founded on either:

- concrete raft,
- perimeter strip footing, or
- driven steel piles.

The concrete raft should be placed on a compacted gravel pad.

A concrete slab on grade, placed on a compacted gravel pad may be used in conjunction with a perimeter strip footing or driven steel piles.

If a perimeter strip footing is used, it should be placed at a depth of at least 1 m below final grade. Insulation will be required around the outside perimeter of the building to protect the footing from frost action.

It is not possible to estimate the probable length of driven piles from the available information. For purposes of the conceptual design, it should be assumed that the driven piles could range up to 20 m in length.

HAY RIVER AIRPORT

Hay River is located about 200 km southwest of Yellowknife and is located within the zone of discontinuous permafrost.

3.1 Site Conditions

The site was cleared when the original runway was constructed several decades ago. The site is well drained and trafficable to construction equipment during the thaw season.

No test hole data was available in the vicinity of the airport. However, based on an examination of airphotos and information from test holes drilled in the Town, the following major soil units are expected below the proposed hangar site:

- alluvial deposits,
- silty clay till.

Alluvial (riverborn) deposits, consisting primarily of loose clayey silts are expected to be present below the site. The silts contain some soft to firm clay layers. Relatively thick alluvial gravel deposits are also frequently encountered within the silts.

The alluvial deposits are expected to be underlain by very stiff silty clay till. The depth of the clay till below this site is not known, but is expected to be within 6 to 10 m below ground surface. The till is believed to extend to depths of over 30 m.

The depth of the groundwater table is expected to range from 1 to 3 m below ground surface.

Permafrost is present in the vicinity of Hay River, primarily in areas which have not been cleared of vegetation. Typically the permafrost melts out 5 to 10 years after an area has been cleared. It is expected, therefore, that there will be no permafrost below the proposed site.

3.2 Taxiways and Aprons

The presence of near surface frost susceptible soils, coupled with a high water table results in significant frost action in this area. Periodic maintenance of the existing runway has been required in order to repair the effects of annual frost action.

Frost heaving of paved surfaces can be reduced by increasing the thickness of granular sub-base and ensuring positive drainage away from these structures. The use of insulation, to control frost penetration below paved surfaces can be considered, however its use under the thermal conditions encountered in Hay River is very uncertain. It is possible that the insulation may aggravate frost heaving by causing aggradation of permafrost below the insulation.

For conceptual design it is recommended that the pavement structure consist of 125 mm of Hot Mix Asphaltic Concrete placed on 250 mm of granular base. The total thickness of the sub-base, base and wearing surface should be at least 1 m.

Paved surfaces should perform satisfactorily, however frost heaving will occur and annual maintenance will probably be necessary.

3.3 Hangar Foundations

The hangar should be founded on driven steel piles. The piles should be driven into the underlying silty clay till. The required length of the piles is uncertain but would probably range from 8 to 12 metres below existing ground surface.

A concrete slab on grade, placed on a compacted gravel pad should be used in conjunction with the piles. The near surface soils are compressible and may settle under the weight of the gravel fill. It would be adviseable to delay pouring the floor slab for as long as possible (say 12 months) after the fill has been placed.

Measures will be required to control frost heaving of foundation elements. The area below the floor slab should not be insulated. Insulation should be placed around the outside perimeter of the structure. A compressible void form (such as "Ethafoam") should be used below grade beams.

FORT SIMPSON AIRPORT

Fort Simpson is located about 400 km west of Yellowknife and is located within the discontinuous permafrost zone.

4.1 Site Conditions

The site was originally treed with spruce. The area was cleared several decades ago when the runway was constructed at Fort Simpson. The site is well drained and trafficable to construction equipment during the thaw season.

No test hole data was available in the vicinity of the airport. However, based on an examination of airphotos, and other information, it is expected that the following soil units are present below the proposed site:

- lacustrine deposits,
- silty clay till.

The site is underlain by lacustrine deposits which consist of compact, interbedded silty sands and silt. The near surface soils consist of silt which are highly frost susceptible. Frost heaving is not a major concern, however, because the water table is relatively deep.

The silty sands and silts are underlain at depth by silty clay till. The till is reported to be present at a depth of 5 to 7 metres.

The depth of the groundwater table is reported to be about 7 metres.

Permafrost is present in the vicinity of Fort Simpson, primarily in poorly drained areas where peat is present. It is unlikely that permafrost is present below the proposed site for the maintenance facility.

4.2 Taxiways and Aprons

The site grading requirements will be controlled by existing topography and surface drainage.

For conceptual design it is recommended that the pavement structure consist of 125 mm of Hot Mix Asphaltic Concrete placed on 250 mm of granular base. The total thickness of the sub-base, base and wearing surface should be least 1 m.

Care should be taken to ensure positive drainage of surface runoff away from pavement structures.

Paved surfaces are expected to perform satisfactorily and no significant post construction settlements or frost heaving are anticipated.

4.3 Hangar Foundations

The hangers could be founded on either:

- concrete raft,
- perimeter strip footing, or
- driven steel piles.

The concrete raft should be placed on a compacted gravel pad.

A concrete slab on grade, placed on a compacted gravel pad may be used in conjunction with a perimeter strip footing or driven steel piles.

If a perimeter strip footing is used, it should be placed at a depth of at least 1 m below final grade. Insulation will be required to protect the footing from frost action.

It is not possible to provide a reliable estimate of the probable length of driven piles from the available information. Based on the limited information available, it is expected that the piles could range from 10 to 15 m in length.

NORMAN WELLS

Norman Wells is located on the Mackenzie River, about 700 km northwest of Yellowknife. Norman Wells is located near the boundary between the zone of continuous and discontinuous permafrost.

5.1 Site Conditions

The proposed site is located in an area in which fill was placed in order to develop an aircraft parking apron for the airport. The fill was placed parallel to the runway, and forms a slope, which is about 3 to 4 m in height, which bisects the proposed hangar site.

Vegetation has been stripped (or covered by fill) on the north half of the site. This area appears well drained and is trafficable to construction equipment during the thaw season.

The trees have been removed from the south portion of the site, but the peat is still in place. This area is moderately well drained but may not be trafficable during the thaw season.

Only very limited data was available with respect to subsurface conditions below the proposed site. The major subsurface soil units are expected to include:

- fill,
- silty clay till,
- clay shale bedrock.

As mentioned, 3 to 4 m of fill are present along the north half of the proposed site. The properties of the fill are not known.

The near surface native soil is expected to consist of silty clay till. The till is of low to medium plasticity and generally contains only minor amounts of excess ice. Vertical ice wedges, ranging up to 1 m in width and many metres deep, are present within the till.

The clay till is expected to be underlain by clay shale bedrock, which generally contains no excess ice. The depth to bedrock below the proposed site, based on limited data, is expected to be from 4 to 7 m below the original ground surface.

It is anticipated that the permafrost has degraded from below those portions of the site from which the peat has been stripped. Permafrost (possibly ice rich) is probably present below those areas in which peat is still present.

5.2 Taxiways and Aprons

Significant depths of fill will be required in order to create a level area for the hangar and associated parking apron. It is essential that the fill below all areas which will be paved, be thoroughly compacted in order to minimize post construction settlements. The existing fill slope should be flattened prior to placing fill.

It is recommended that the fill be placed at least 2 years prior to paving in order to minimize settlements due to post construction consolidation of the fill and foundation soils.

For conceptual design, it is recommended that the pavement structure consist of 125 mm of Hot Mix Asphaltic Concrete placed on 250 mm of crushed rock base. This structure must be placed on a thaw stable compacted fill. The gravel fill (crushed limestone) below the pavement should be at least 1 m in thickness.

It should be noted that the permafrost in Norman Wells is relatively warm and sensitive to surface disturbance. Despite all precautions, it is possible that some settlements of paved surfaces may occur in the future. For example, settlement due to thawing of vertical ice wedges has been a maintenance problem for the existing runway.

5.3 Hangar Foundations

If the hangar is constructed on the north half of the site, in which permafrost is not expected to be present, the structure could be founded on driven steel piles. The piles should be driven through the fill and at least 3 m into the underlying bedrock. It may be necessary to prebore the pile holes into the bedrock. The concrete floor may be placed on compacted crushed rock fill, at least 1 m in thickness. It can be expected, however, that some settlement of the floor will occur after construction, as the fill consolidates or as isolated ice lenses in the silty clay till melt out. It may be necessary to repair or replace some sections of the concrete floor.

If the structure is founded on driven steel piles with a slab on grade floor, it is essential that a comprehensive drilling and sampling program be carried out on the specific building site, in order to confirm that significant excess ice is not present in the overburden soils and within the underlying shale bedrock.

If the structure is founded on the south half of the site, below which permafrost may be present, it may be necessary to found the hangar on a concrete raft, with a cooling system similar to that described for the proposed Inuvik site.

INUVIK AIRPORT

Inuvik is located on the East Channel of the Mackenzie River, about 1100 km northwest of Yellowknife. The Town is located within the continuous permafrost zone.

6.1 Site Conditions

The area in the vicinity of the runway is vegetated with stunted black spruce and spagnum moss. The ground surface in undeveloped areas is poorly drained and not trafficable to construction equipment during the thaw season.

The soils below the proposed hangar site are expected to include the following major units:

- crushed rock fill,
- peat,
- silty clay till,

- clay shale bedrock,
- dolomite bedrock.

Crushed rock fill has been placed over the proposed site. The thickness of the fill is not known but is probably about 2 m.

Peat, having an average thickness of 0.3 m, but possibly ranging up to 2 m in thickness, is expected to be present below the fill. The peat is black, fibrous and highly compressible when thawed.

The peat is possibly underlain by a silty clay till. The till contains occasional boulders, cobbles and gravel. The clay till contains significant quantities of excess ice. Ice lenses ranging up to 1 m in thickness have been observed in some locations. The clay till is of low to medium plasticity and is very soft when thawed.

The silty clay till is possibly underlain by clay shale. In some locations in this area, the shale unit is absent. The clay shale is of medium to high plasticity and contains up to 10 percent excess ice by volume. Excess ice contents in the shale generally decrease with depth.

The shale is underlain by dolomite bedrock. The dolomite is exposed in the quarries at the west end of the runway, where it is hard, grey, light brown and red in colour and well jointed. The depth to dolomite bedrock below the airport has been found to range from 2 to 18 m below ground surface. The depth to dolomite bedrock is highly variable and the upper few metres of the dolomite bedrock are expected to be weathered and fractured. Open joints and fractures in the weathered dolomite can be expected to contain ice.

Sinkholes (due to the collapse of solution cavities within the dolomite) have not been reported in the vicinity of the airport, however the two circular lakes at the west end of the runway are suggestive of such features.

The maximum depth of thaw in undisturbed areas ranges from 0.5 to 1 m. The depth of thaw in crushed rock fill can range up to 3 m depending on water contents. Ground temperatures at a depth of about 6 m during the late fall, have been found to range from -1.8 to -3.1°C in areas where undisturbed peat is present.

6.2 Taxiways and Aprons

Crushed rock fill is required in all locations in this area in order to provide trafficability for construction vehicles.

In those areas where asphalt pavements are to be placed it is important to ensure that the annual thaw does not penetrate below the base of the granular fill into the underlying ice rich soils. Based on previous experience with the existing runway, it is recommended that the required minimum thickness of granular fill below pavement structures be 3.0 metres. This thickness can be made up of granular fill alone or, where required to achieve the design grade, a combination of granular fill and insulation. A thermal analysis should be carried out during detailed design to confirm the thickness of fill and insulation used below pavement structures.

The thickness of crushed rock fill placed on the proposed site is not known, but it is suspected it is less than 3 m. It is expected that it will be necessary to add fill and insulation in order to achieve a thaw stable base for the pavement structure. If fill is added, there may be difficulties in complying with maximum allowable grades on aircraft taxiways. In this regard, it should be noted that the apron for the AES hangar, which was constructed on less than 3 m of fill, has experienced significant thaw settlement since it was paved. It is recommended that paving be delayed for as long as possible (at least two thaw seasons) after the additional insulation and fill has been added, in order to reduce the risk of post construction settlements.

The design of the asphalt pavement structure for parking aprons and taxiways will depend on the maximum wheel loads and aircraft tire pressures. For conceptual design, it is recommended that the pavement structure consist of 125 mm of Hot Mix asphalt concrete and 250 mm of crushed rock base. This structure must be placed on thaw stable compacted fill, as discussed above.

6.3 Hangar Foundations

The hangar can be founded on a concrete raft foundation placed on compacted crushed rock fill.

It will be necessary to install a cooling system below the raft in order to prevent heat from the hangar from thawing the ice rich soils below the compacted fill. Three systems can be considered:

- Forced air ventilation,
- Thermosyphons,
- Refrigeration.

Forced air ventilation consists of a series of air ducts through which air is blown during the winter months. Rigid extruded polystyrene insulation is placed between the air ducts and the concrete raft. For conceptual design, it may be assumed that 500 mm ducts, placed at 3 m centres, with 150 mm of insulation will perform satisfactorily. A minimum of 3 m of crushed rock fill would be required below the top of the concrete slab in order to prevent thawing the ice rich soil below the fill.

Thermosphyons consist of a sealed steel pipe which is partially filled with liquid carbon dioxide or ammonia. The liquid in the below ground portion boils and the vapour rises to the above ground radiator. The vapour condenses and flows back down under gravity to the below ground section. This cycle operates as long as air temperatures are colder than ground temperatures, as is generally the case during the winter. For conceptual design it may be assumed that thermosphyons will be spaced at 2.5 m, with an insulation thickness of 150 mm and a gravel fill thickness of 3 m.

Refrigeration pipes can be used to cool the area below the slab and prevent thaw degradation. Most units consist of a primary circuit which circulates freon while a secondary circuit circulates brine below the floor slab. The operating costs of a refrigeration system are generally high. However, because the system operates during the summer as well as in the winter, it is possible to reduce the thickness of gravel fill placed below the floor slab, to about 2 m.

The thickness of the existing fill on this site (about 2m) is less than normally required for either forced air ventilation or thermosyphon cooling systems. If the slab elevation cannot be raised because of limitations on taxiway gradients, it may be necessary to use the more expensive refrigeration system.

A thermal analysis will be required during detailed design to establish the minimum fill thickness and the most suitable cooling system for this particular site.

C Facility Specifications

OVERALL FEATURES SHEET

FACILITY: GNWT Hangar Facility
AREA: 4129 m^2

LOCATION: Northwest Territories
DATE: August, 1990

REFERENCE	DESCRIPTION
Asphalt Apron	xx
Concrete Apron	xx
Aircraft Tie Downs	xx
Explosion Panel	Flammable Storage
Floor Hardeners	xx
Loading Dock Equipment	Stores
Overhead Cranes	5 Ton Capacity
Jib Cranes	
Compressed Air	xx
Painting Operations	Shop
AFFF Fire Protection	
Drinking Fountains	xx
Underground Tanks	Used Oil/Solvent
Drench Shower/Eyewash	xx
Heating Systems	Forced Air
Engine Start Air	
Oil Separator	xx
Aircraft Wash Station	xx
Hose Bibbs	Exterior, Non-Freeze
400 Hz Electrical	xx
28V DC Electrical	xx
Lightning Protection	
Obstruction Lighting	xx
Exterior Lighting	Apron/Security
Building Grounding	xx
Emergency Power	
Aircraft Static Grounding	xx
P.A. System	xx
Security System	xx

COMMENTS:

1. Hangar doors - electrically operated, 600 V, protected bus duct conductor system.
2. GPU power supply - hangar area = 4, ramp area = 2
3. Equipment
   - Crane (bucket type)/cherry picker
   - Forklift 2500 lb. capacity, 10 foot lift, side shift carriage, battery charger
   - Office furnishings
   - Powered floor cleaner/washer
4. Exterior lighting to be equipped with photocells.
5. 350 Amp, 600/347 V, 3 ø electrical supply.
6. 10,000 gallon fuel tank.
7. 10,000 gallon water reservoir (where watermain supply is not available)
8. Underslab radiant heating should be considered in locations not subjected to permafrost conditions.

FEATURES SHEET

FUNCTION: Hangar
AREA: 2997 m^2

LOCATION: Northwest Territories
DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	57300 mm
Width	51800 mm
Glazing	Double, Low E
Clear Height	12500 mm (min)
Overhead Doors	one
Special Doors	
Mandoors	xx
Wall Finish	Exposed Batt
Floor Finish	Light Relective
Ceiling	Exposed Batt
STRUCTURAL	
Floor Loading	L-100-30
Min. Column Spacing	7315 mm
Special Foundations	
Service Pits	
Floor Finish	Hardeners
MECHANICAL	
Water Supply	xx
Sanitary Drainage	Double Sink
Compressed Air	Eight Outlets - 100 psi
Unit Heaters	
H + V	Forced Air
HVAC	
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	Four Catchbasins
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	HPS - 65 ft. Candles
Fluorescent Lighting	
Other Lighting	Task
Heat Detectors	xx
Intrusion Alarm	xx
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	xx
Speakers	xx
Baseboard	
Computer Outlets	

COMMENTS:

1. Hangar water supply - 3" single outlet (cold)
2. HW/CW outlets - Eight (8)

FEATURES SHEET

FUNCTION: Stores
AREA: 428 m^2

LOCATION: Northwest Territories
DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	2400 W x 2400 H (2)
Special Doors	
Mandoors	xx
Wall Finish	Drywall
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	
Sanitary Drainage	
Compressed Air	
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	xx
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	xx
Speakers	xx
Baseboard	
Computer Outlets	xx

COMMENTS:

1. Stores to contain
   - Wheels area
   - Flammable storage/Oil stores
   - Purchasing office
   - Main stores
   - Shipping/receiving
2. Hangar to be used for storage of large items such as engine stands, ground equipment and engines.
3. Lift Table required, 6000 lb. capacity.
4. Store to have electrical services for computers, facsimile machine and photocopiers.

FEATURES SHEET

FUNCTION: Engine Q.E.C.

AREA: 56 m^2

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	3000 W x 2400 H
Special Doors	
Mandoors	
Wall Finish	Concrete
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	Hardener
MECHANICAL	
Water Supply	xx
Sanitary Drainage	Double Sink
Compressed Air	xx
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	xx
Special Drainage	
Fire Extinguishers	
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3φ, 60A	
600V, 3φ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Crane - Monorail, Hoist, 1 Ton

FEATURES SHEET

FUNCTION: Sheet Metal/Welding

AREA: 46 m^2

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	2400 W x 2400 H
Special Doors	
Mandoors	
Wall Finish	Concrete
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	Hardener
MECHANICAL	
Water Supply	
Sanitary Drainage	
Compressed Air	xx
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	Welding Exhaust
Infrared Heating	
Supply Fans	
Floor Drainage	
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3φ, 60A	
600V, 3φ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Shop to accommodate tig welder and oxy-acetylene equipment.

FEATURES SHEET

FUNCTION: Machine
AREA: 46 m²

LOCATION: Northwest Territories
DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	2400 W x 2400 H
Special Doors	
Mandoors	
Wall Finish	Concrete
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	Hardener
MECHANICAL	
Water Supply	xx
Sanitary Drainage	Single Sink
Compressed Air	xx
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	xx
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Crane - Monorail, Hoist, 1 ton.
2. Equipment - Metal lathe.
3. Eyewash required in room.

FEATURES SHEET

FUNCTION: Avionics/Electrical Accessories

AREA: 46 m²

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	
Special Doors	
Mandoors	Solid Core
Wall Finish	Drywall
Floor Finish	Vinyl Tile
Ceiling	Accoustic Tile
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	
Sanitary Drainage	
Compressed Air	xx
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	xx
Speakers	
Baseboard	
Computer Outlets	xx

COMMENTS:

1. Nicad battery storage area to be included.
2. 220 Volt outlets - Two (2).

FEATURES SHEET

FUNCTION: NDT
AREA: 23 m^2

LOCATION: Northwest Territories
DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	
Special Doors	
Mandoors	
Wall Finish	Drywall
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	xx
Sanitary Drainage	
Compressed Air	xx
Unit Heaters	
H + V	Supply Only
HVAC	
Exhaust Fans	xx
Infrared Heating	
Supply Fans	
Floor Drainage	xx
Special Drainage	
Fire Extinguishers	
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Magnaflux tester.

FEATURES SHEET

FUNCTION: Cleaning/Degreasing

AREA: 9 m^2

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	
Special Doors	Double Mandoor
Mandoors	
Wall Finish	Concrete
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	
Sanitary Drainage	
Compressed Air	xx
Unit Heaters	
H + V	Supply Only
HVAC	
Exhaust Fans	xx
Infrared Heating	
Supply Fans	
Floor Drainage	
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Equipment - Self contained varsol spray booth 1200 x 1200.
2. Provide solenoid connection between compressed air supply and exhaust fan.

FEATURES SHEET

LOCATION: Northwest Territories
DATE: August, 1990

FUNCTION: Battery
AREA: 5 m^2

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	
Special Doors	
Mandoors	
Wall Finish	Drywall
Floor Finish	Concrete
Ceiling	Drywall
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	xx
Sanitary Drainage	Single Sink
Compressed Air	
Unit Heaters	
H + V	
HVAC	
Exhaust Fans	xx
Infrared Heating	
Supply Fans	
Floor Drainage	xx
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Single Sink to be stainless steel.

FEATURES SHEET

FUNCTION: Paint

AREA: 28 m'

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	2400 W x 2400 H
Special Doors	
Mandoors	xx
Wall Finish	Concrete
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	Hardener
MECHANICAL	
Water Supply	xx
Sanitary Drainage	Single Sink
Compressed Air	xx
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	xx - Explosion Proof
Fluorescent Lighting	
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx - Explosion Proof
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Single Sink - stainless steel.
2. Tanks - Paint stripping
   - Acid etching
   - Alodine
   - Hot water parts washing/rinse tank
3. Forced warm air drying rack.
4. H + V to be separate unit designed for spray booth.

FEATURES SHEET

FUNCTION: Mechanical/Electrical

AREA: 37 m^2

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	
Special Doors	
Mandoors	xx
Wall Finish	Drywall (rated)
Floor Finish	Concrete
Ceiling	Exposed Structure
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	
Sanitary Drainage	
Compressed Air	
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	xx
Infrared Heating	
Supply Fans	
Floor Drainage	xx
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Compressor to be large capacity (turbine) type c/w air dryer and filters.
2. Main electrical switchboard, communications board and intrusion alarm system.
3. Hot water boiler system.

FEATURES SHEET

FUNCTION: Administration
AREA: 408 m^2

LOCATION: Northwest Territories
DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	Double, Low E
Clear Height	2600 mm
Overhead Doors	
Special Doors	
Mandoors	Solid Core
Wall Finish	Drywall
Floor Finish	Carpet
Ceiling	Acoustic Tile
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	
Sanitary Drainage	
Compressed Air	
Unit Heaters	
H + V	
HVAC	xx - Zone Control
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	
Special Drainage	
Fire Extinguishers	xx
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	xx
Intrusion Alarm	xx
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	xx
Speakers	
Baseboard	xx
Computer Outlets	xx - UPS System

COMMENTS:

1. Lobby - 600 x 600 acoustic tiles, pot lights, ceramic floor tile.
2. Administration areas - 1200 x 600 acoustic tile, recessed light fixtures.
3. Lighting - 80 ft. candles.
4. Exterior mandoor - insulated, closures
5. Built-in safe.
6. Lunchroom - drinking fountain, vinyl tile, sink/cupboard unit, electrical power for vending machines, refrigerator, microwave.
7. Boardroom - dimmable light fixtures
8. Inspection office/library - vinyl flooring
9. Acoustically insulate from hangar.

FEATURES SHEET

FUNCTION: Washrooms

AREA: (Included in Administration)

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	
Special Doors	
Mandoors	Solid Core
Wall Finish	Drywall
Floor Finish	Ceramic Tile
Ceiling	Drywall
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	xx
Sanitary Drainage	Vanities
Compressed Air	
Unit Heaters	
H + V	Supply Only
HVAC	
Exhaust Fans	xx
Infrared Heating	
Supply Fans	
Floor Drainage	xx
Special Drainage	
Fire Extinguishers	
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	Surface
Other Lighting	
Heat Detectors	
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3ϕ, 60A	
600V, 3ϕ, 100A	
Telephone Outlets	
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. GFI receptacle in each washroom.
2. Lockers - Twenty (20) half units.

FEATURES SHEET

FUNCTION: First Aid

AREA: (Included in Administration)

LOCATION: Northwest Territories

DATE: August, 1990

REFERENCE	DESCRIPTION
ARCHITECTURAL	
Length	
Width	
Glazing	
Clear Height	
Overhead Doors	
Special Doors	
Mandoors	Solid Core
Wall Finish	Drywall
Floor Finish	Vinyl Tile
Ceiling	Acoustic Tile
STRUCTURAL	
Floor Loading	
Min. Column Spacing	
Special Foundations	
Service Pits	
Floor Finish	
MECHANICAL	
Water Supply	xx
Sanitary Drainage	xx
Compressed Air	
Unit Heaters	
H + V	xx
HVAC	
Exhaust Fans	
Infrared Heating	
Supply Fans	
Floor Drainage	
Special Drainage	
Fire Extinguishers	
Sprinklers	
ELECTRICAL	
HID Lighting	
Fluorescent Lighting	xx
Other Lighting	
Heat Detectors	
Intrusion Alarm	
Duplex Receptacles	xx
208V, 3φ, 60A	
600V, 3φ, 100A	
Telephone Outlets	xx
Speakers	
Baseboard	
Computer Outlets	

COMMENTS:

1. Provision for single bed.
2. Sink/cupboard unit.